

## **CORRECTIVE ACTION PLAN**

## TRANS-JORDAN LANDFILL

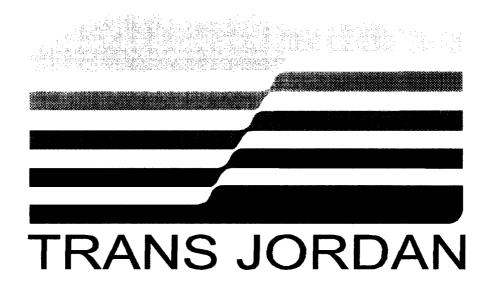


## **CORRECTIVE ACTION PLAN**

### **Trans-Jordan Cities**

**FOR** 

## TRANS-JORDAN LANDFILL



September 10, 2003

GENERAL MANAGER: DWAYNE J. WOOLLEY

ENGINEER: IGES, BRETT MICKELSON, P.E.

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#### TRANS-JORDAN LANDFILL GROUND WATER REVIEW

#### General

The Trans-Jordan Landfill (TJL) began operation in 1958 and is a cooperatively operated solid waste landfill operated by Trans-Jordan Cities (TJC). TJC was officially formed as a political subdivision of the State of Utah in 1986 to dispose of solid wastes generated in the southern half of Salt Lake County. TJC operates under an Interlocal Agreement between its' member cities (the Cities of Draper, Midvale, Murray, Riverton, Sandy, South Jordan, and West Jordan) with a combined population of 307,000 (2000 census). The TJL is overseen by a board of directors with each member city having one board position. Daily operations and management of the Landfill is coordinated by Mr. Dwayne J. Woolley, General Manager.

TJL in conjunction with South Valley Water Reclamation Facility (SVWRF) cooperatively fund the operation and maintenance of a wood products and green waste grinding facility established in 1996. SVWRF is the operator of this facility located immediately south and adjacent to the landfill.

During 1999, TJL constructed and placed on-line, a citizen drop-off facility at the landfill. The citizen drop-off facility is comprised of two areas, one area provides a safe area for citizen unloading of residential wastes, and a second area is used to separate Household Hazardous Waste (HHW) and recyclables from the waste stream. The HHW program is a joint operation with Salt Lake Valley Health Department (SLVHD).

The existing landfill facility is located on TJC owned land in Section 15 of Township 3 South, Range 2 West. The street address for the landfill is 10873 South 7200 West, South Jordan Utah.

Landfill access is provided from U-111 (old State Route 111) at the landfill site's northwest corner. TJL is located within the city of South Jordan and West Jordan city limits are approximately 1/2 mile northeast. The community of Herriman lies approximately 3 miles south-southeast and Copperton is 1.5 miles to the west. Drawing 1 (Attachment 1) shows the general arrangement of the TJL site.

#### **Ground Water Monitoring Requirements**

The State of Utah Department of Environmental Quality Division of Solid and Hazardous Waste (DSHW) in conjunction with (SLVHD) regulate the design, construction and operation of municipal solid waste (MSW) landfills in Salt Lake County. Section R315-308 of the State regulations and Health Regulation #1 of Salt Lake County stipulate requirements required for ground water monitoring at MSW facilities.

#### **Detection Monitoring:**

Each facility must have at least one upgradient well and two downgradient wells. During the first year of facility operation after the wells are installed, a minimum of eight independent samples from the upgradient and four independent samples from each downgradient well are analyzed for the constituents in Section R315-308-4 to establish background water quality. The detection monitoring program requires the owner or operator of the facility to semiannually determine ground water quality at each monitoring well during the operation, closure and post-closure care period of the facility.

If, during the performance of the detection monitoring, a constituent is detected in the downgradient wells that has a statistically significant increase over the upgradient (background) water quality, the facility owner or operator must:

- Enter the information in the operating record of the facility.
- Notify the Executive Secretary (DSHW) and Director (SLVHD) of the findings.
- Immediately resample all wells to further evaluate the water quality.

If there is a statistically significant increase over background of any constituent, the owner or operator of the facility has 90 days to demonstrate that the source of the contamination is not associated with the facility. If the facility does not establish that the contamination is not associated with the facility, the ground water monitoring program moves into assessment monitoring.

#### **Assessment Monitoring:**

Assessment monitoring starts with sampling all downgradient wells and analyzing the water for all constituents listed in Appendix II of 40 CFR Part 258. For any constituent detected in the Appendix II list, a minimum of four independent samples must be collected, analyzed, and statistically analyzed to establish background concentrations. The owner or operator of the facility shall sample quarterly and compare the concentrations to ground water protection standards.

If after two consecutive sampling events, the concentrations of all constituents being analyzed are shown to be at or below established background values, the owner or operator must notify the Executive Secretary and upon approval return to detection monitoring.

If concentrations of any of the constituents are statistically measured at concentrations exceeding the protection standards, the owner or operator must notify the Executive Secretary, local health officials, and adjacent landowners, then characterize the nature and extent of the release. If the owner or operator can not demonstrate that the source of the contamination is other than the landfill, then the facility enters into a corrective action phase.

#### Corrective Action:

As a facility enters into corrective action, the owner or operator of the facility takes any interim measures to protect human health and the environment and assesses possible corrective actions. Based upon the corrective action assessment and public comment, the owner or operator must select a remedy which shall be submitted to the Executive Secretary.

Upon approval of the selected corrective action, the Executive Secretary will notify the owner or operator of such approval and will require that the corrective action plan proceed according to the approved schedule.

#### TJL Ground Water Monitoring Program

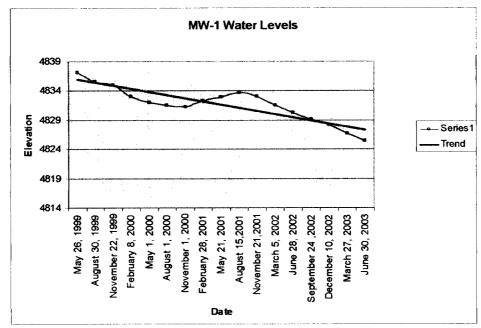
A ground water monitoring program was initiated in March of 1994 with the installation of monitor well one (MW-1). Water from MW-1 was compared with water well data in the vicinity of the landfill and it was determined that MW-1 was completed in a perched water system not representative of the documented low pH water known to be found in surrounding Kennecott Utah Copper (KUC) wells. As a result MW-1 has not been used as an upgradient well. Installation of monitor well two (MW-2) was performed in January of 1995 to serve as the upgradient monitor well for water quality evaluations. Monitor well three (MW-3) was installed in December of 1995 and served as the initial downgradient well for water quality evaluations.

Monitor well four (MW-4) was installed in November of 1997 to function as the second downgradient well. Monitor well five (MW-5) was installed in August of 1998 to monitor ground water closer to the active cell.

These sampling wells were originally located based on the predominant groundwater flow being west to east. However, down gradient pumping and the recent construction of a surface and alluvial cutoff system by KUC and other activities related to the Copper Mine located up gradient from the site, have each altered the groundwater conditions at the landfill. Drawing 2 (Attachment 1) shows the location of the five TJL monitoring wells.

#### **Ground Water Elevations**

Modifications to the ground water recharge regime (by KUC), several years of below average precipitation and increased demand on downgradient wells have all contributed to the drop in ground water elevations, drying up 2 of TJL monitor wells. The groundwater elevations in the two remaining downgradient monitoring wells (MW-4 and MW-5) have dropped by over 1 foot in the last 3 months. The following graphs illustrate the decreasing water levels for the last 4 years for each of the monitoring wells. The bottom of each of the graphs corresponds to the bottom elevation of each well:



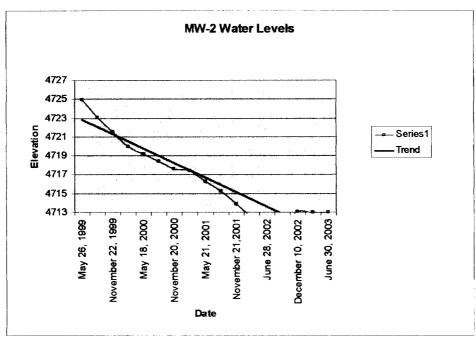
Well #1 Data: Well Depth = 365'

Bottom Elev. = 4814'

Initial Water Column = 39'

Water Column Remaining = 11'

Well #1 Status: Not currently utilized for groundwater analysis.



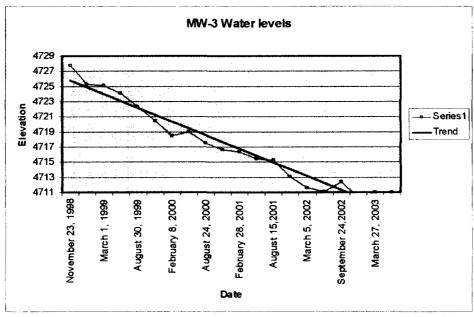
Well #2 Data: Total Depth = 455'

Bottom Elev. = 4713'

Initial Water Column = 34.5'

Water Column Remaining = 0

Well #2 Status: No viable sample since June 2002



Well #3 Data:

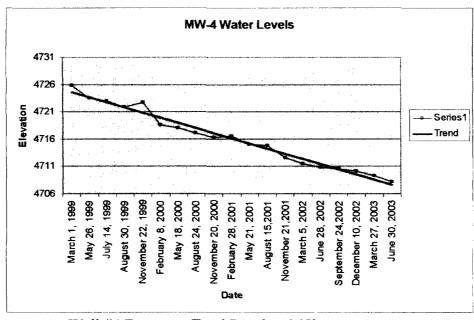
Total Depth = 319'

Bottom Elev. = 4711'

Initial Water Column = 30.5'

Water Column Remaining = 0

Well #3 Status: No viable sample since June of 2002



Well #4 Data:

Total Depth = 365',

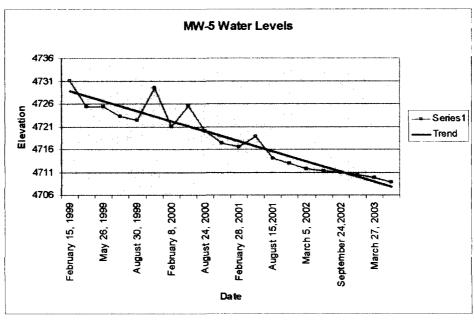
Bottom Elev. = 4706'

Initial Water Column = 22'

Water Column Remaining = 2'

Well #4 Status:

Operational (Projected date being dry: 1st quarter 2004)



Well #5 Data: Total Depth = 365,

Bottom Elev. = 4706'

Initial Water Column = 21'

Water Column Remaining = 3'

Well #5 Status: Operational (Projected date being dry: 1st quarter 2004)

#### **Ground Water Quality**

The most recent summary of the ground water quality at the TJL is presented in the 2002 Ground Water Monitoring Report, which was part of the annual landfill report submitted to DSHW in February of 2002. This Ground Water Monitoring Report presents the results of recent ground water analysis, including ground water chemistry, depth to water and the interpreted direction of ground water flow under the TJL. The "Trans-Jordan Landfill 2002 Ground Water Monitoring Report" is included as Attachment 2.

#### Potential Constituents of Concern

The 2002 Ground Water Monitoring Report details the procedures for analyzing the concentration of constituents in ground water. The ground water at TJL is analyzed for ground water constituents as prescribed by the DSHW regulations. Most of the chemicals analyzed for are either non-detect or are present at low enough concentrations to not exceed ground water standards. Statistical analysis is performed on all measurable constituents to determine if ground water is potentially being impacted from landfilling operations.

Potential Constituents of Concern for TJL are the following organic compounds:

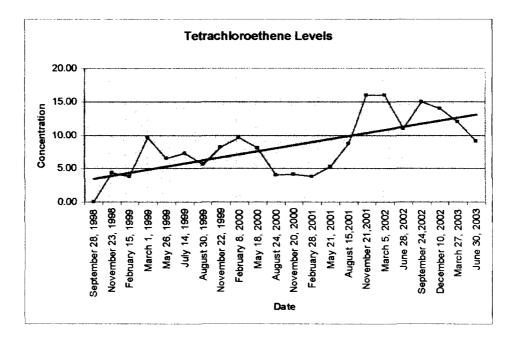
#### • 1,1 Dichloroethene

- Tetrachloroethene
- 1,1,1 Trichloroethane
- Trichloroflouromethane
- Dichlorodiflouromethane

Of the five potential constituents of concern listed above, four (1,1 Dichloroethene, 1,1,1 Trichloroethane, Trichloroflouromethane, and Dichlorodiflouromethane) have been measured in the ground water at TJL at concentrations lower that the ground water protection standards.

Only Tetrachloroethene in TJMW-5 was identified as a constituent of concern, which is identified as having concentrations higher than the groundwater protection standards and having higher concentrations downgradient than upgradient.

The following chart shows the concentration of Tetrachloroethene over time in well #5:



Confidence Interval analysis for Tetrachloroethene utilizing the data through March 2003 showed that Tetrachloroethene has exceeded the ground water protection standard of 5 parts per billion with all data subsets.

#### CORRECTIVE ACTION #1 – ACCELERATED CLOSURE OF UNLINED LANDFILL

#### General

Tetrachloroethene (PCE) is a dense non-aqueous phase liquid (DNAPL). One problem with the chlorinated solvents is that they are heavier than water and can result in deep

contamination. PCE can migrate under the influence of gravity as a liquid, or can volatize and migrate in a vapor phase. Due to the nature of PCE, depth to ground water, and the inherent challenges in investigating the source and mechanism of the PCE transport, TJC proposes to mitigate both of the primary mechanisms for transport.

The first of the corrective actions summarized in this plan will be to minimize the potential for liquid based solute transport by constructing a landfill cover system that will reduce the infiltration of liquid into the landfill. TJC has modified the landfilling operations to accelerate the closure of the unlined landfill. The active landfill face has been moved from the lined cells and located over the unlined landfill to bring the unlined area to a final grade sooner. Bringing the unlined landfill to grade sooner will allow for the installation of a synthetic cover over the top of the unlined area in the most time efficient manner and minimize the potential infiltration of water into the MSW. TJC has elected to incorporate synthetic materials for cover construction rather than a monolithic soil cover to improve methane collection, storm water management and infiltration reduction efforts. Reducing the infiltration of water in the landfill will minimize the generation of leachate which will reduce the potential for additional PCE transport in a liquid medium.

To accomplish the accelerated closure of the unlined landfill, while maintaining a manageable landfill operation, TJC has developed a phased closure plan for the entire landfill operation. The following presents the scheduled closure phases at the Landfill:

#### Side Slopes Closure

Drawing 3 (Attachment 1) indicates the areas of the landfill to be covered with a minimum of 5' of acceptable soil cover. Drawing 3 also shows the locations that test pits have been excavated to document soil depth and the locations of future test pits. Once final cover soils have been placed on the remaining side slopes, test pits will be excavated to document the remaining side slopes soil thickness. All side slopes will have received final cover by late fall of 2003. The side slopes indicated on the drawing are slopes that in general bound the unlined areas of the landfill.

TJL has accelerated the side slope closure, as previously discussed with DSHW personnel, to aid in the implementation of the first corrective action. All side slopes will receive a minimum of 5 feet of site soils. All test pits excavated to date showed the minimum 5-foot cover thickness. Once test pits are excavated in the remaining areas to document cover thickness, topsoil and/or compost will be placed on all side slopes and the areas revegetated.

All areas of the landfill will be closed in accordance with applicable final cover requirements in the regulations.

#### Closure Phases A through H

Phases A through H as indicated on Drawings 4, 5, 6, and 7 (Attachment 1) represent the future closure phases of the landfill. The cover system utilized in Phases A through H will incorporate synthetic materials designed to the lower liner permeability criteria of the lined cells. The utilization of synthetic materials in the cover design will aid in the design and operation of a future landfill gas recovery system.

The approximate closure schedule and associated area for each Phase is as follows:

Phase	Cover Area	Date of Closure
North side slopes	26 acres	Summer 2003
Phase A	11 acres	Summer 2004
Phase B	7 acres	Summer 2005
Phase C	10 acres	Summer 2007
Phase D	15 acres	Summer 2011
Phase E	17.5 acres	Summer 2016
Phase F	18.5 acres	Summer 2021
Phase H	30.5 acres	Summer 2030

#### Duration of Corrective Action #1

All landfill covers will be maintained from initial installations through the closure, and through the post-closure care periods.

#### **CORRECTIVE ACTION #2 – INSTALLATION OF A GAS COLLECTION SYSTEM**

#### General

The second of the corrective actions summarized in this plan will be to install a landfill gas collection system that will depressurize the landfill while recovering methane, thus minimizing the potential for a vapor phase transport of the PCE.

The installation of a gas recovery system is part of a comprehensive waste management plan that is being implemented at the landfill. Installation of the system allows for the safe, long-term methane management that will help to minimize the potential for further environmental impacts to the ground water.

#### Existing Gas Recovery Design

As part of the New Source Review program of the State of Utah Division of Air Quality, TJC had a methane collection system designed. The design of the methane collection system met the requirements of the Air Quality Regulations and, at the time of the design, represented the anticipated closure sequence of the landfill.

The existing gas collection system design was prepared by HDR Engineering, Inc. in 1999 and had provisions for some 45 vertical wells uniformly distributed across the landfill. The design package included all requisite engineering details and specifications to support a bid package.

#### Gas to Energy Project

TJC has prepared and issued a request for proposal (RFP) for a Landfill Gas-to-Energy Project (LGEP) dated January 13, 2003. The LGEP is a proactive solicitation for a partner in the beneficial use of landfill gas.

The RFP was well received with 6 firms submitting proposals in April of 2003. Trans-Jordan personnel reviewed and ranked all 6 proposals based upon landfill gas-to-energy experience, project approach, schedule and proposed fee. Out of the 6 proposals, 3 were selected to prepare presentations to Trans-Jordan's personnel. The 3 remaining bidders were given additional information reflecting the change in closure sequence and additional site-specific data. Final presentations to TJC were conducted the 21<sup>st</sup> of August 2003. TJC is in the process of negotiating with the vendor of choice and will proceed with the landfill gas to energy project this fall.

TJL will install a gas collection system as part of its methane management plan, but with the price of natural gas steadily increasing, the prospects of a viable gas-to-energy project increase substantially.

#### System Construction

The construction of any gas collection system or gas-to-energy system will be of a phased nature. The system will be installed concurrent with or just subsequent to the closure of each of the Phases outlined previously.

#### **Duration of Corrective Action #2**

Landfill gas will be continually collected from the initial system installation through closure and post-closure care periods or until landfill gas is measured below 25% of the LEL for Methane in the system.

#### **CORRECTIVE ACTION #3 – KUC GROUND WATER RECOVERY SYSTEM**

#### General

The third and final portion of the proposed corrective actions summarized in this plan is a ground water recovery system being implemented by KUC. Though KUC is responsible for the aspects of their ground water recovery program, TJC appears to be an indirect beneficiary of KUC's actions. KUC actions, independent of the Corrective Actions #2 and #3 may mitigate TJL impact to the ground water.

#### Geologic Background

The TJL is located in the southwestern portion of the Jordan River Valley, usually called the Salt Lake Valley, east of the northern Oquirrh Range and the mouth of Bingham Canyon. Bingham Creek flows from the Oquirrh Range eastward down Bingham Creek (immediately north of the landfill) and out into the Salt Lake Valley to the Jordan River. West of the landfill area are the mining operations of the Bingham Canyon Mine which is located at the confluence of Bingham and Carr Fork Canyons. The Bingham Mining District has been developed in intrusive and meta-sedimentary rocks.

#### **KUC Ground Water Impacts**

Kennecott Utah Copper has been conducting mining operations west of the landfill location for decades. As part of the mining operations, a reservoir (Bingham Canyon Reservoir) has been operated in the Bingham Creek drainage to serve as storage for process waters. The reservoir is located hydraulically upgradient from the TJL, approximately 8,900 feet to the west. Seepage losses from the historic operation of the Bingham Creek Reservoir have been estimated at over 1,000,000 gallons per day since construction in 1965. The Bingham Creek Reservoir (unlined) has since been decommissioned and replaced with a lined reservoir, but the residual downgradient acid and sulfate waters still remain. Additionally, KUC has installed several groundwater cutoff walls.

The affected ground waters have been estimated to extend over 20,000 feet downgradient to the east and about 10,000 feet wide, fully encompassing the landfill. The sulfate concentration in some of the monitor wells within the plume has historically exceeded 50,000 mg/l with some pH values less than 3.0.

Previous hydrogeologic work has delineated a 10,000 mg/l TDS contour line running beneath the landfill. The wide range in TDS concentrations in the study area reflects the impact of historic mining operations on the groundwater.

#### **KUC Ground Water Treatment**

KUC has been working with the State of Utah Division of Water Quality for several years to implement a groundwater recovery and treatment plan. KUC's recovery effort involves pumping impacted groundwater from a network of wells designed and installed to recover both the low pH water and the high TDS waters. "The Southwest Jordan Valley Ground Water Cleanup Project" is currently undergoing a public comment period while preliminary work has already been started. A new acid recovery well has been installed within 200 feet of the TJL boundary. The volume of water pumped from this well and others located near the landfill will drastically alter the groundwater elevations under the landfill. KUC has shared information on two of the possible pumping scenarios.

Scenario #1 pumping rates:	Scenario #2 pumping rates:	
Zone A:	Zone A:	
Acid Well 1146 (950 gpm)	Acid Well 1146 (950 gpm)	
New Acid Well (750gpm)	New Acid Well (750gpm)	
Jordan Wells (2600 acre feet/yr)	W. Jordan Wells (2600 acre feet/yr)	
Lark Well (200 gpm)	Lark Well (200 gpm)	
Sulfate Well (1000 gpm)	Sulfate Well (1000 gpm)	
Sulfate Well B2G1193 (1100gpm)	Sulfate Well B2G1193 (1700gpm)	
Sulfate Well B2G1200 (1100gpm)	Sulfate Well B2G1200 (1700gpm)	
Riverton Wells (4308 acre feet/yr)	Riverton Wells (4308 acre feet/yr)	
Zone B:	Zone B:	
Wells 1-6 (235gpm each)	Wells 1-6 (235gpm each)	
Well 7 (1200 gpm)	Well 7 (1200 gpm)	

#### 10, 20, and 40 Year Drawdowns

KUC's drawdown data for each of the above scenarios is presented on Drawings 8, 9, 10, 11, 12 and 13 (Attachment 1). Drawings 8, 9, and 10 represent the predicted groundwater drawdown for scenario #1 at 10, 20, and 40 years. Drawings 11, 12, and 13 represent the predicted groundwater drawdown for scenario #2 for the same 10, 20, and 40 year periods.

The predicted 10-year groundwater drawdown for the groundwater in the vicinity of the landfill ranges from 30 to 60 feet. The predicted 20 and 40-year groundwater drawdowns for the landfill areas are from 50 to 80 feet and 70 to 90 feet respectively.

#### **KUC Water Destinations**

Water from the acid wells will be directed to the KUC tailings ponds north of Magna and water recovered from wells B2G1193 and BFG1200 will be sent to a reverse osmosis plant for treatment to drinking water standards for public use.

#### **Duration of Corrective Action #3**

The duration of the KUC recovery actions is scheduled for the next 40 years. When the groundwater under TJL has reached equilibrium, groundwater will be sampled and analyzed to document that the Corrective Action was successful.

#### **FUTURE GROUND WATER MONITORING**

#### Impacts to Trans-Jordan Landfill's Ground Water Monitoring

As previously detailed, the groundwater under the landfill is dropping. Two of the five monitoring wells are now dry and the two remaining downgradient wells are anticipated to become dry within 9 months. The predicted drop of ground water and subsequent drying out of MW-4 and MW-5 does not include an increase in the rate of ground water drop due to the upcoming pumping plan. If water recovery efforts start soon, the entire groundwater monitoring system at the landfill may be rendered useless.

#### New Well Installation

These two pumping scenarios may not be the only variations in a KUC plan, but are only the scenarios shared with TJC. The impacts to the groundwater elevations under and surrounding the landfill might be enormous. Based upon the magnitude of the groundwater elevation change, the level of accuracy of the modeling, and the numerous scenarios being considered, the true impact to the groundwater elevations are still unknown.

The anticipated drawdown of the ground water surface may result in the change of direction of flow of the groundwater under the landfill. The effects of the change in direction of flow are also an unknown.

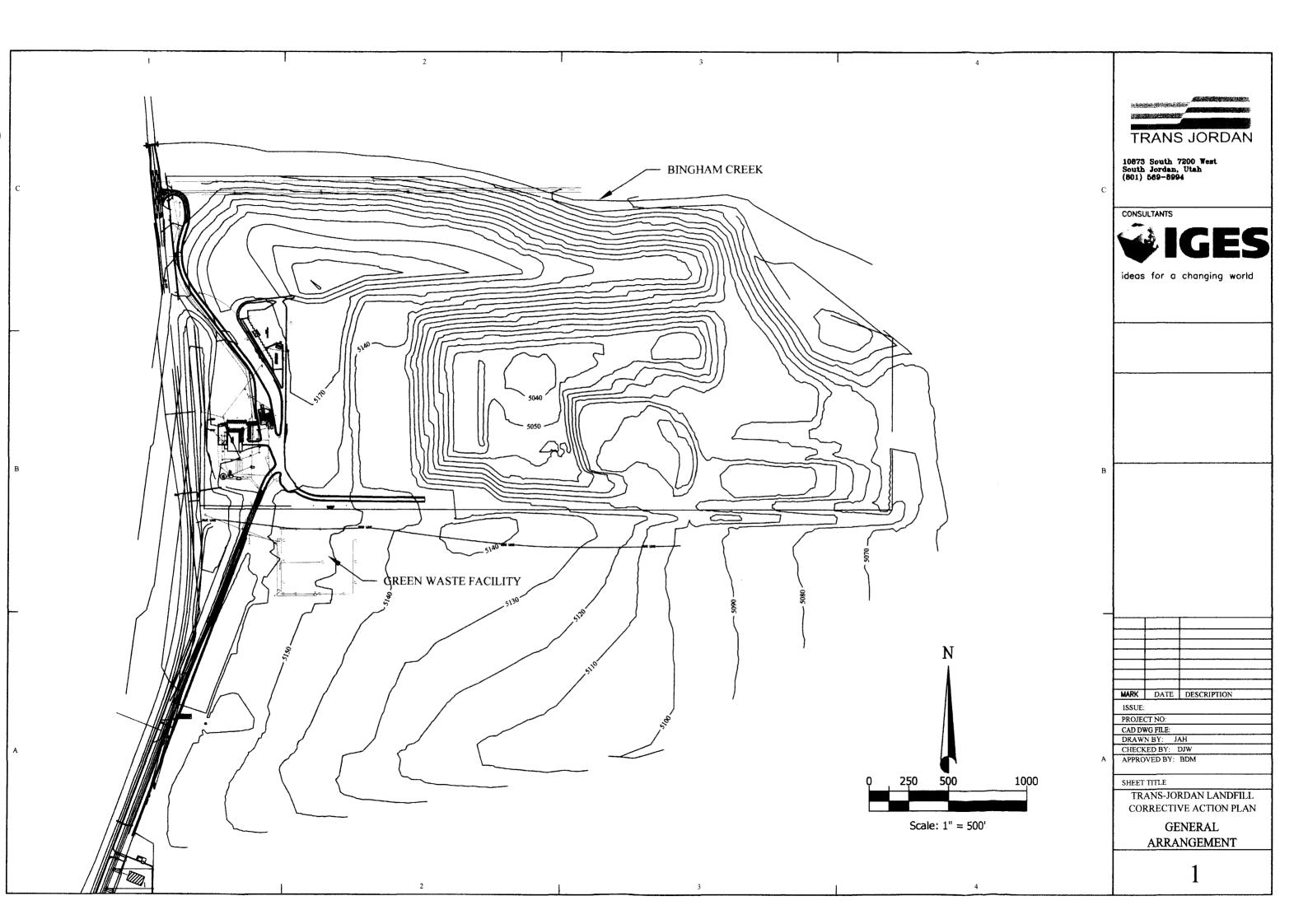
The magnitude of these unknowns (final depth to groundwater and final direction of flow) are such that the location selection for and the installation of a new monitor well is extraordinarily difficult. Without knowing the steady state conditions associated with the remediation efforts, the installation of a new well will have a low likelihood of providing useful water quality data. As a result, TJC proposes to not install a new groundwater monitoring well.

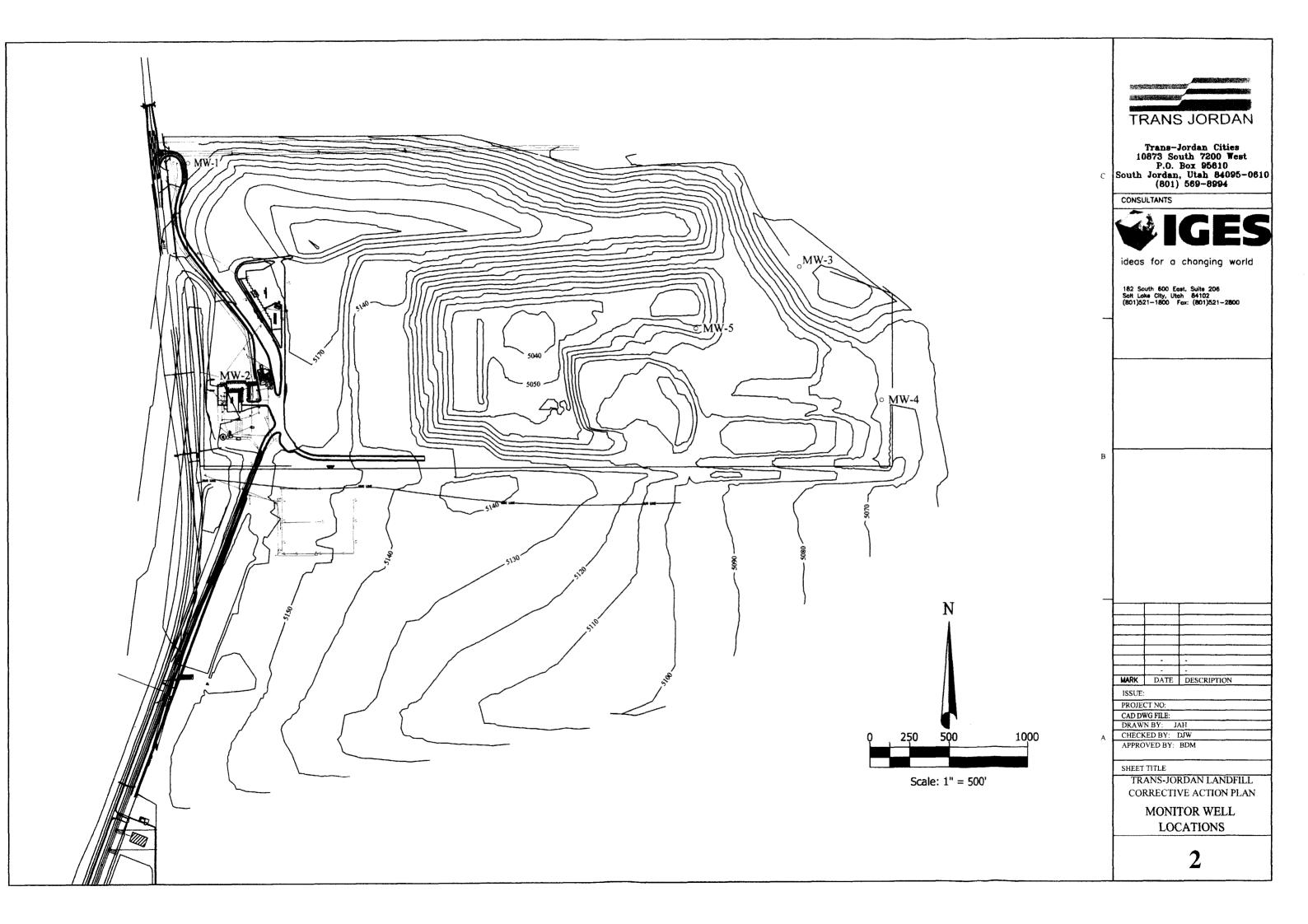
#### **Proposed Ground Water Monitoring**

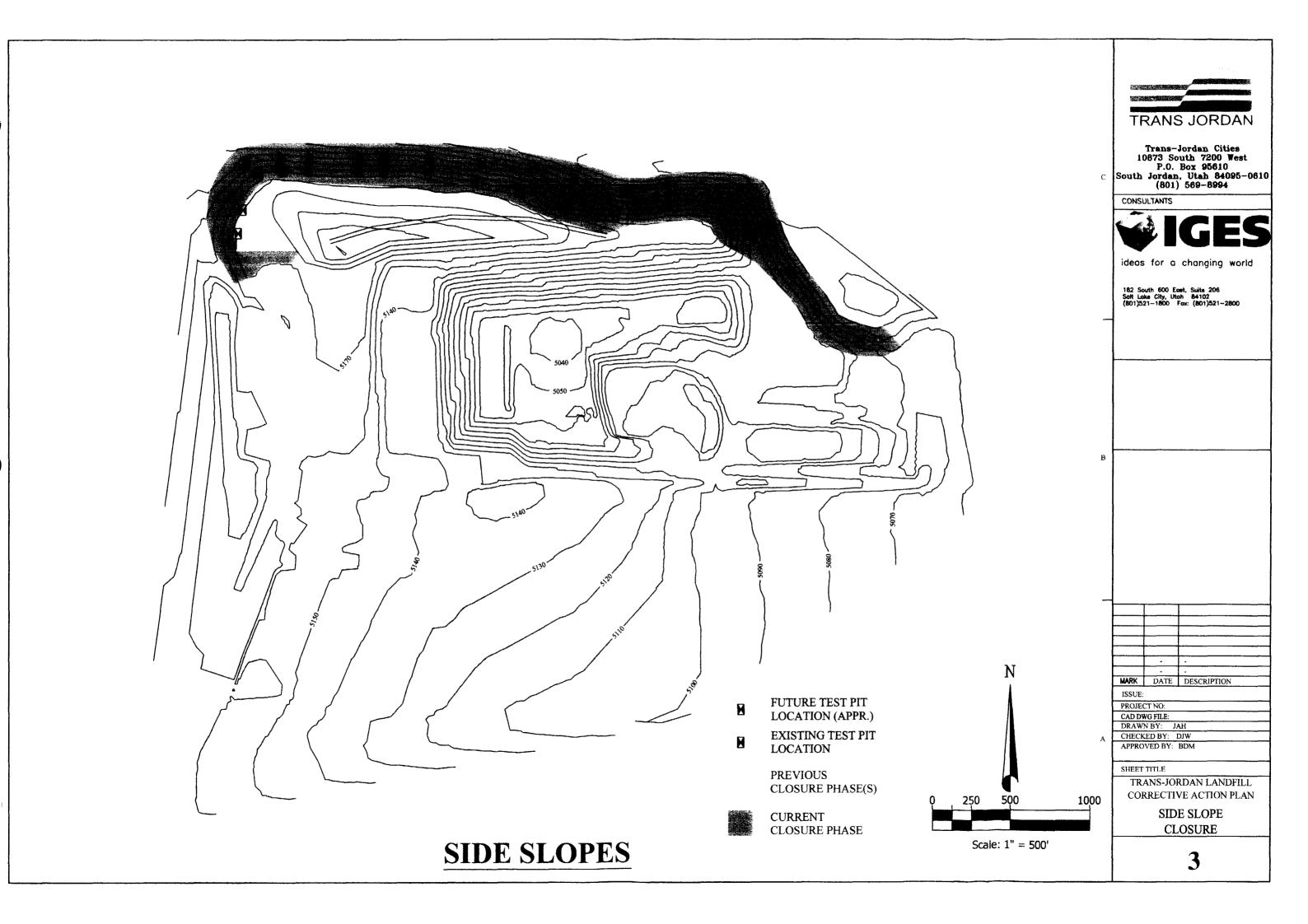
TJC is in contact with KUC and discussing the potential of accessing adjacent KUC wells for potential groundwater sampling.

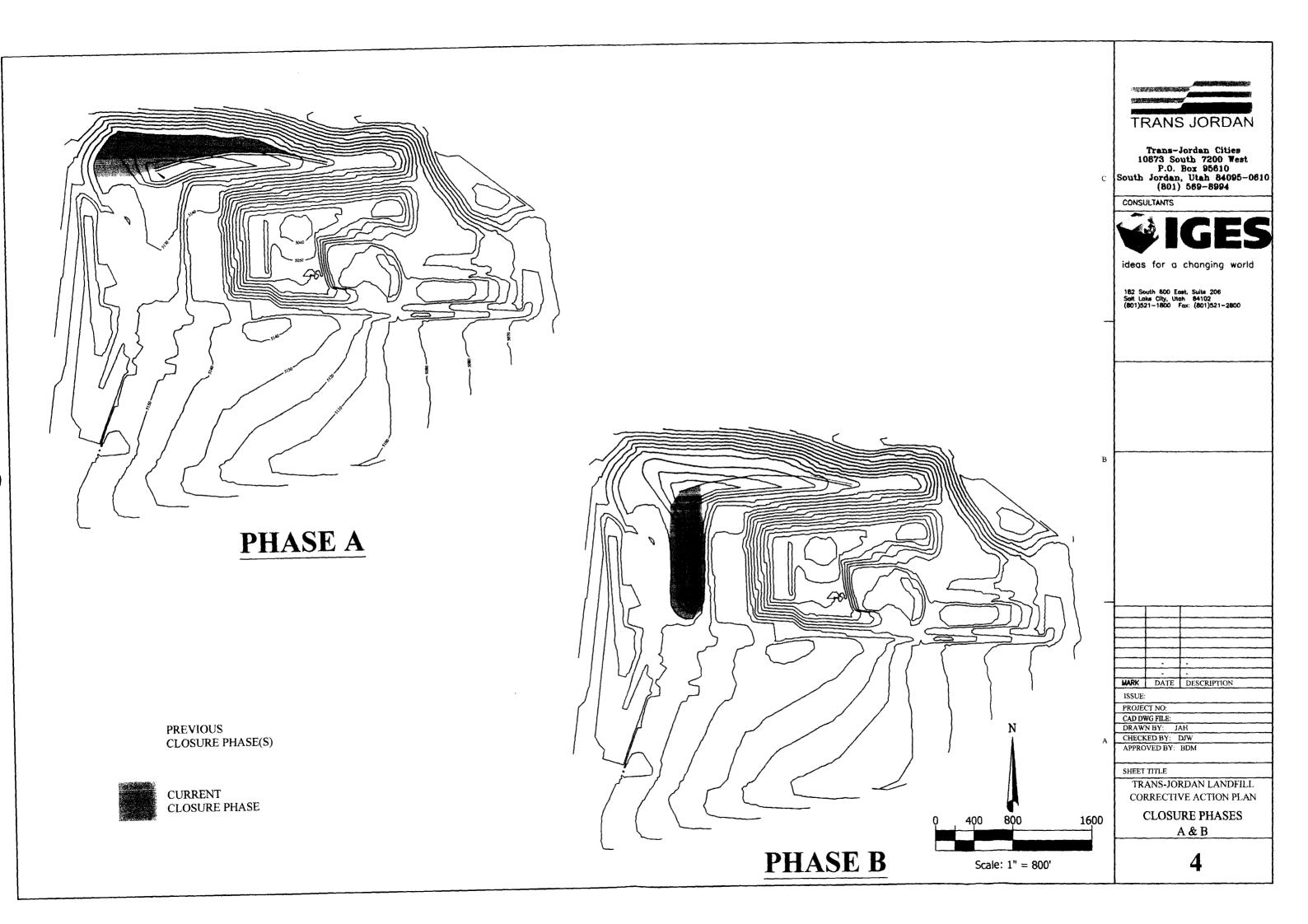
Since the KUC recovery system is currently being brought on line and evaluated, TJC will issue a proposed groundwater monitoring plan once additional input from KUC is received, but in no event later than November 1<sup>st</sup> 2003.

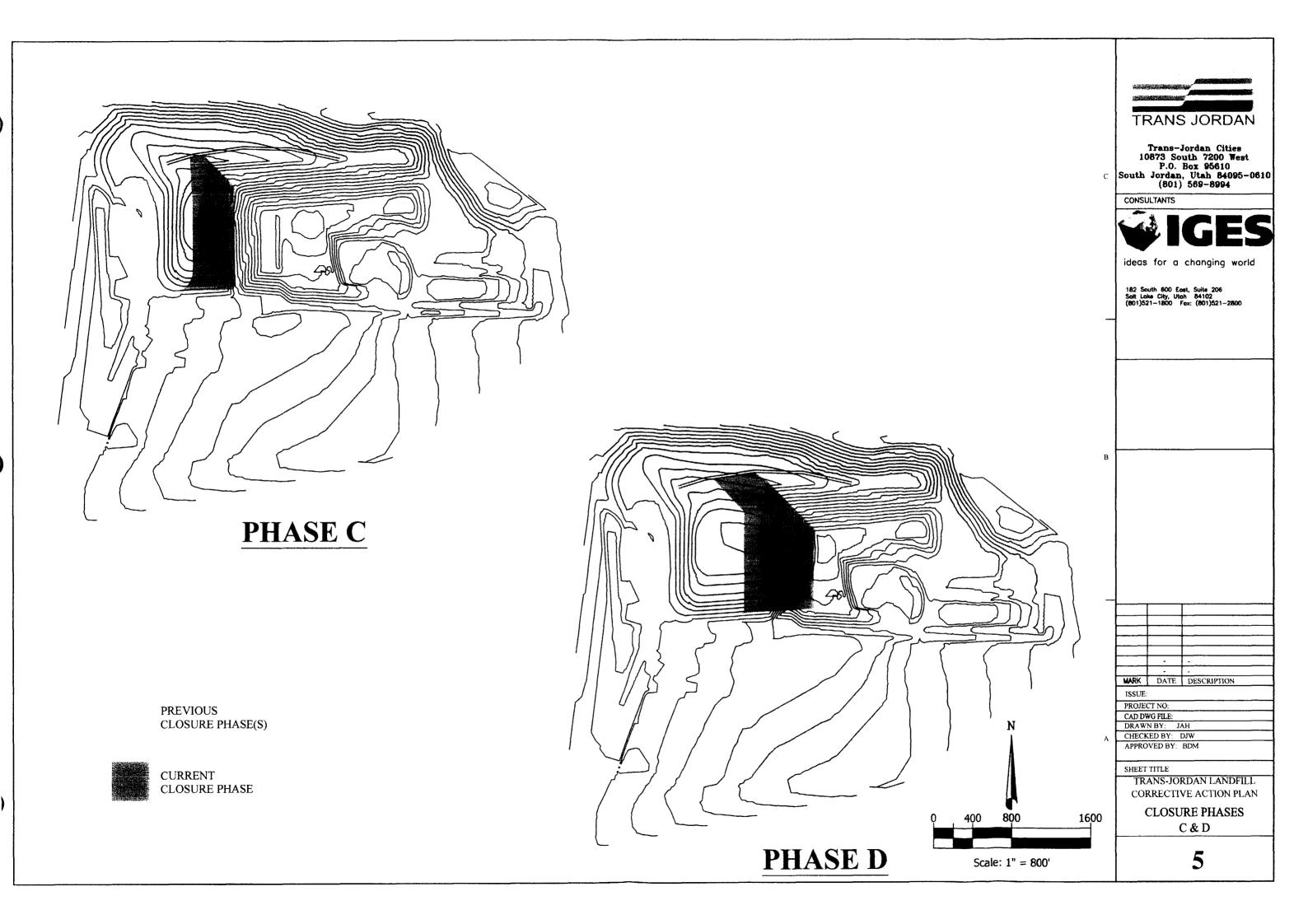
# Attachment 1

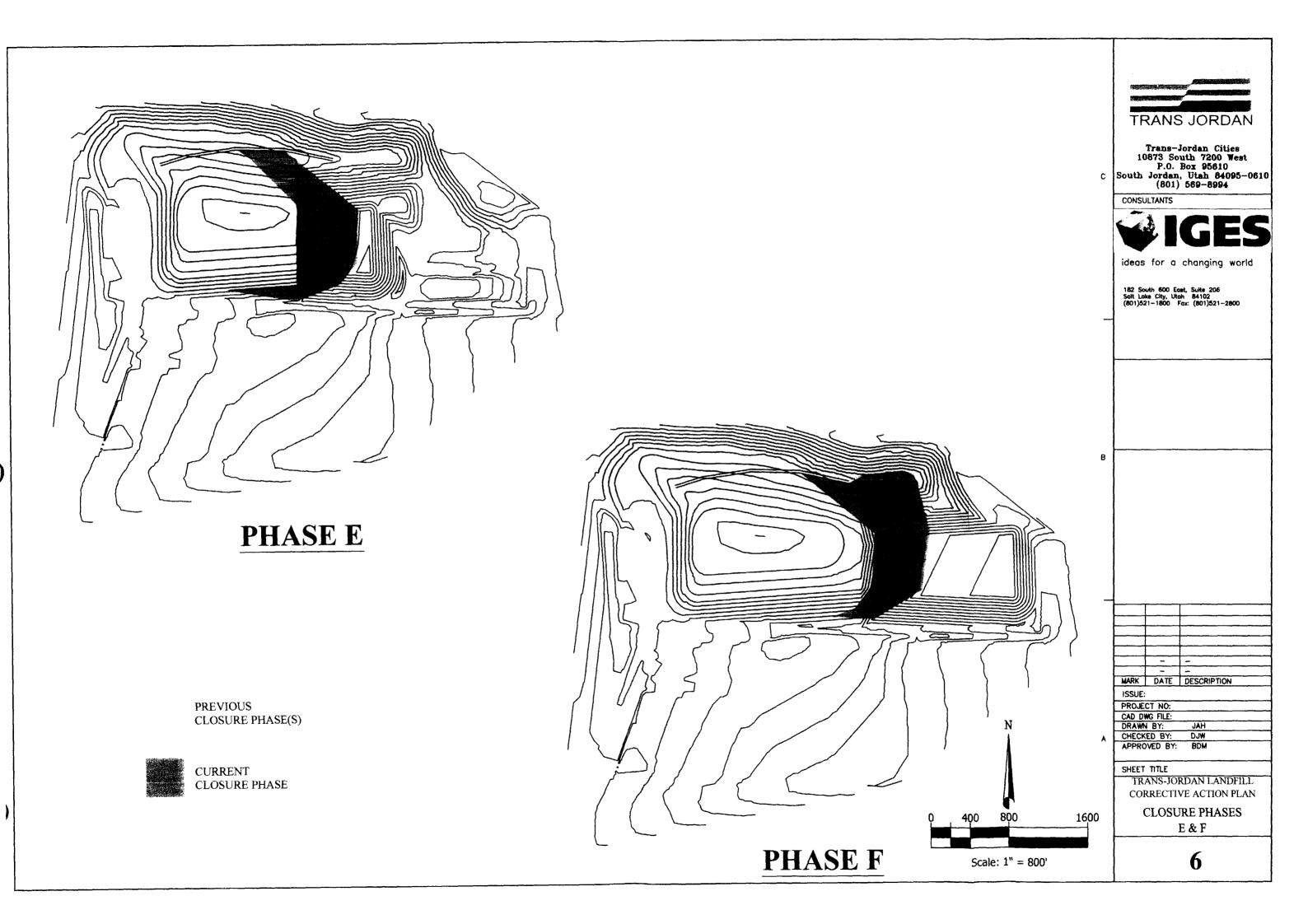


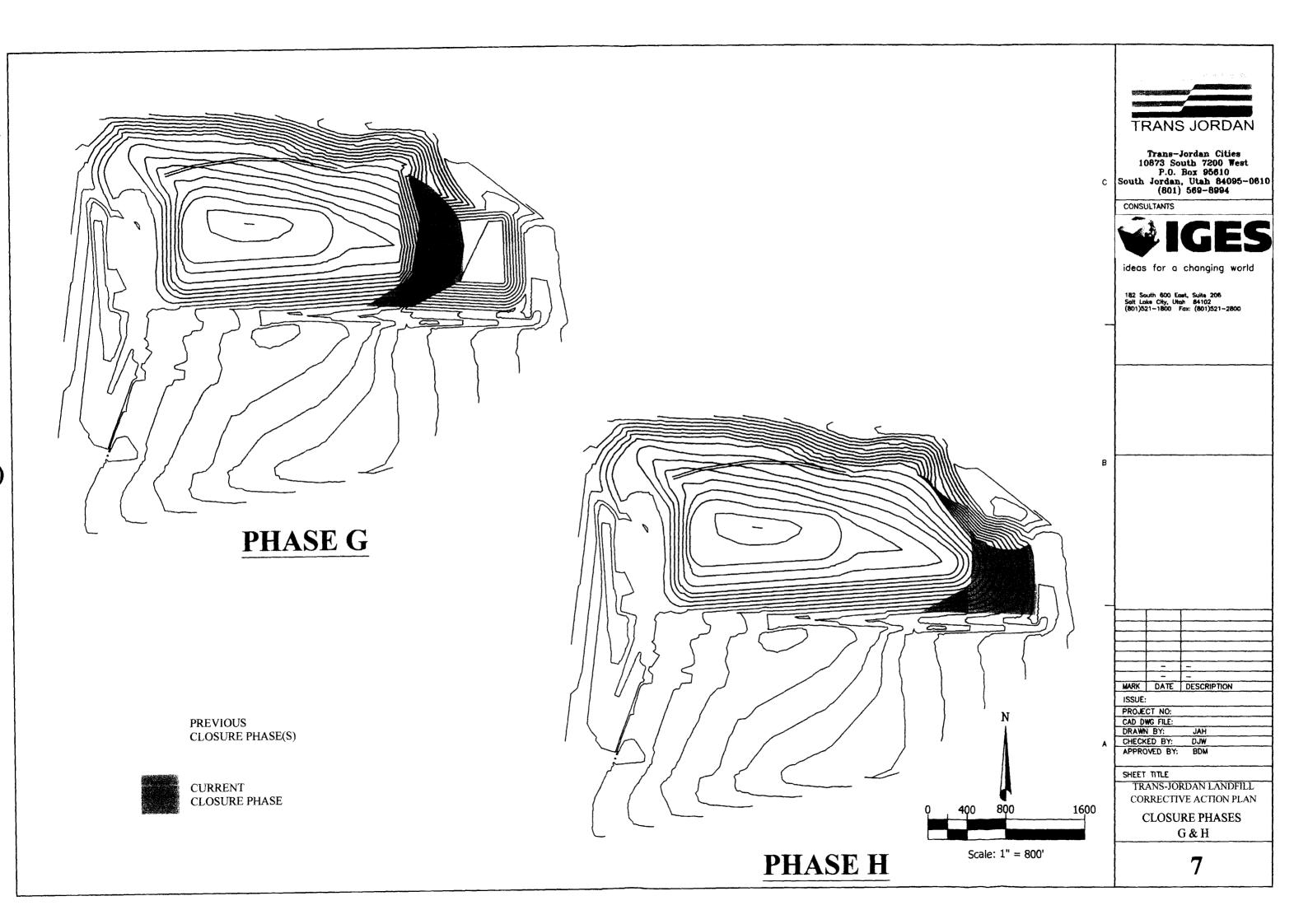


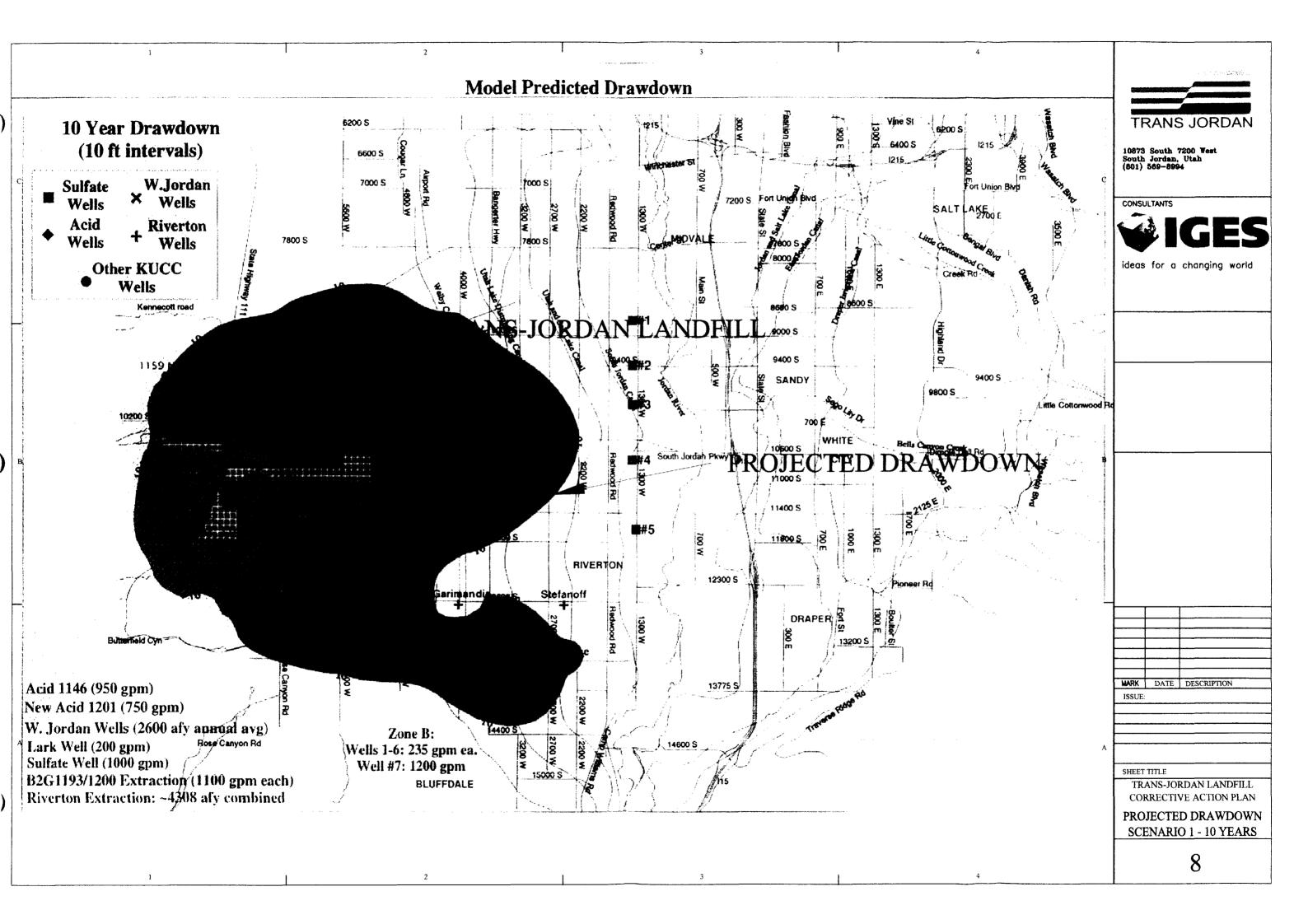


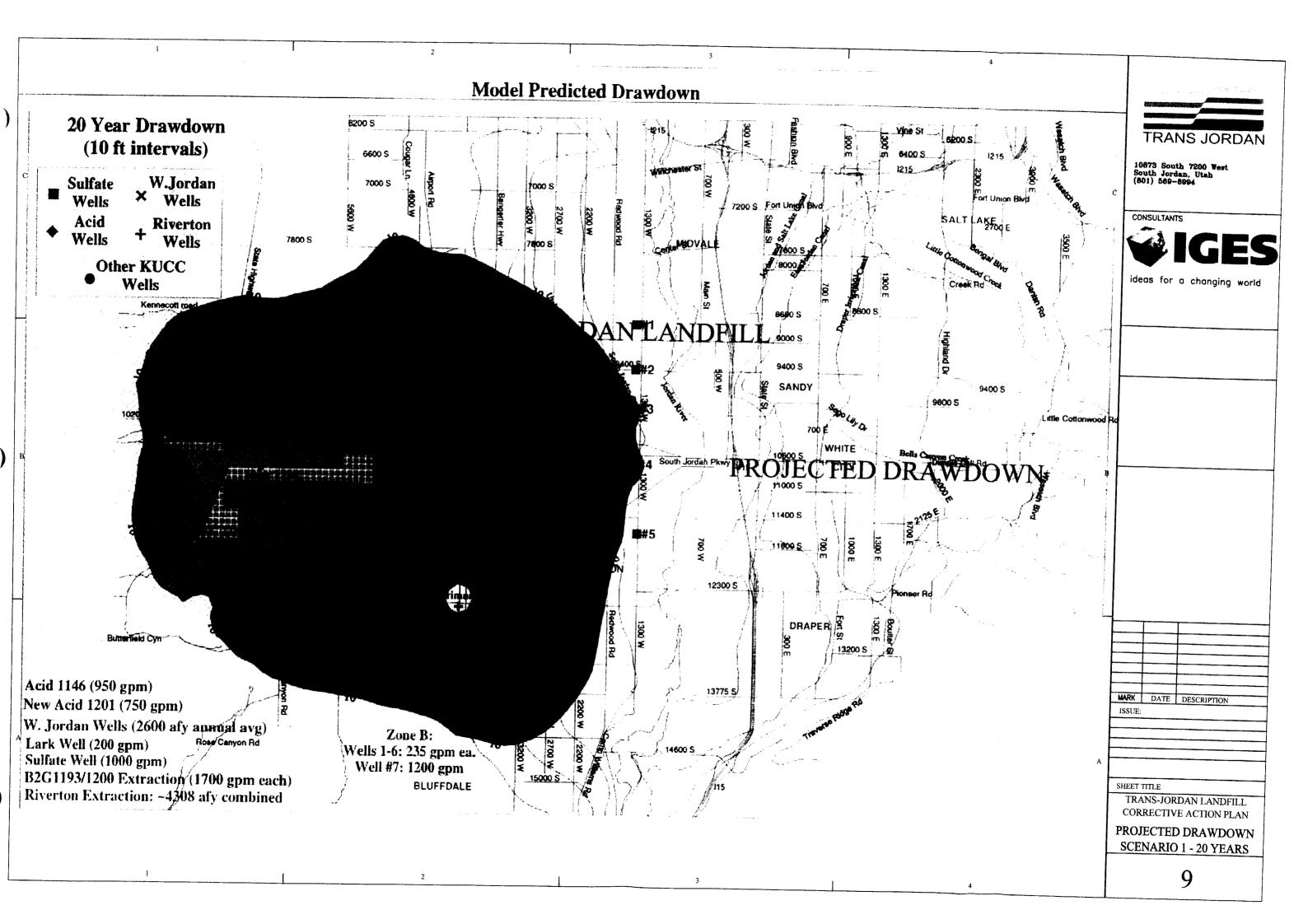


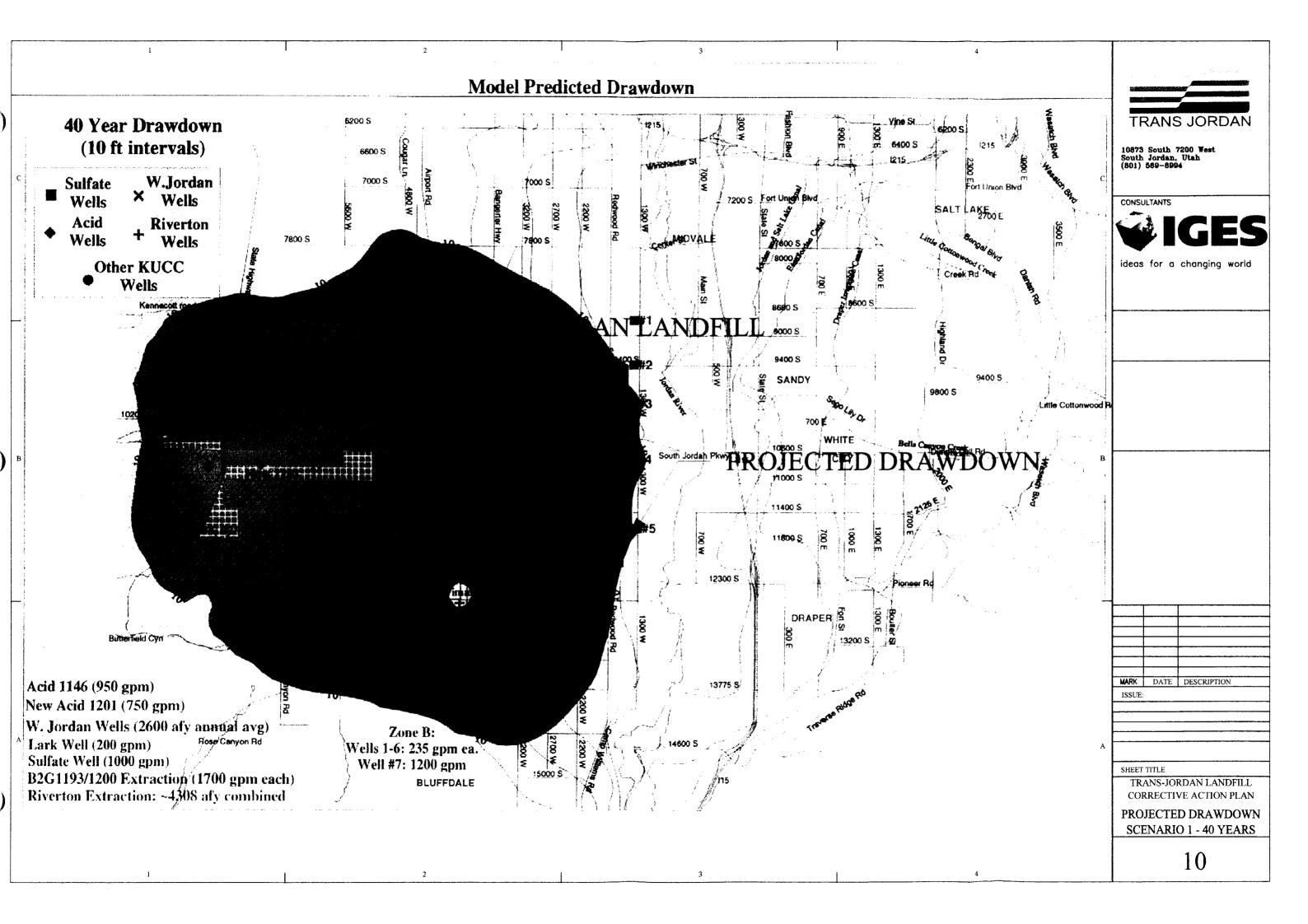


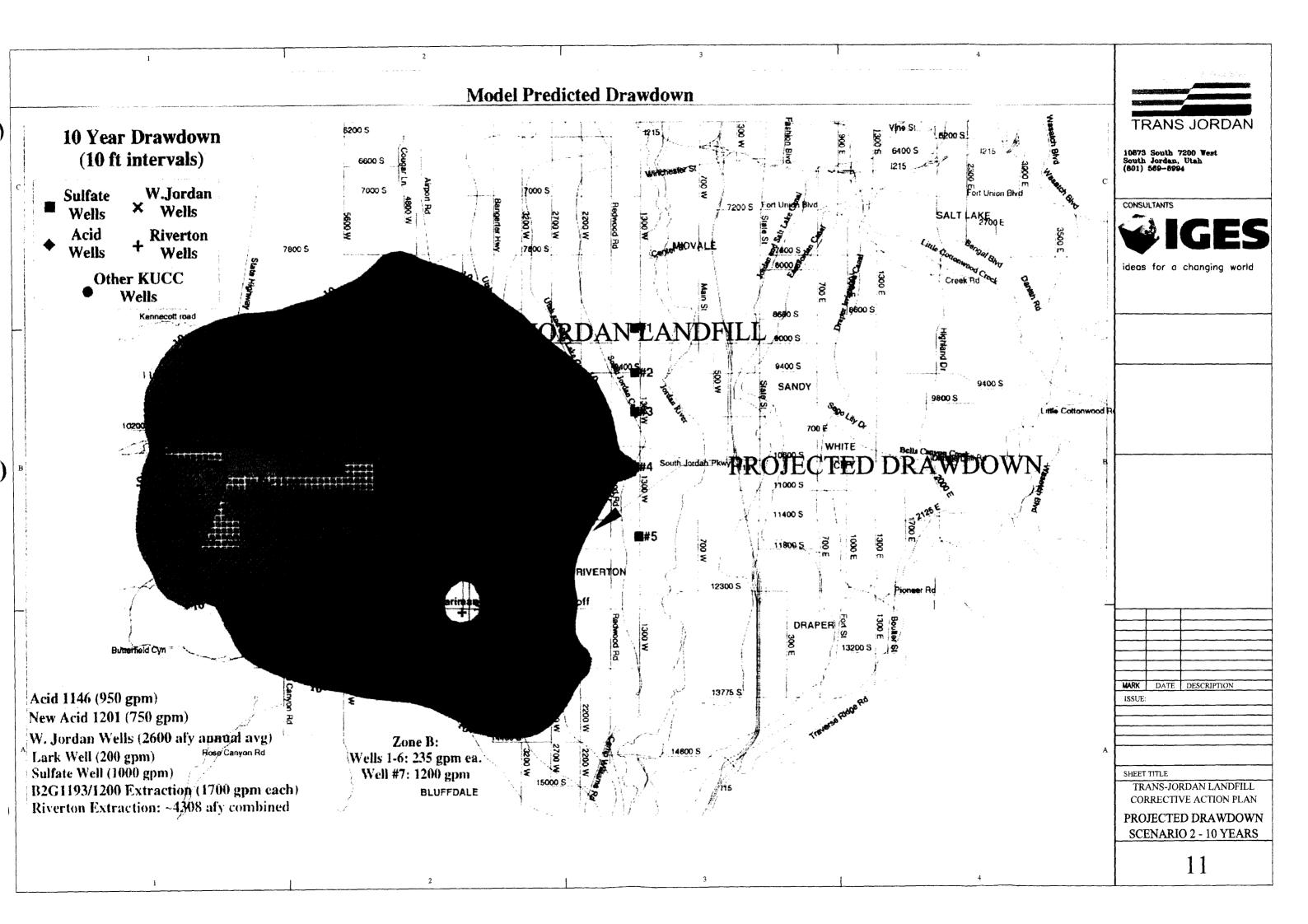


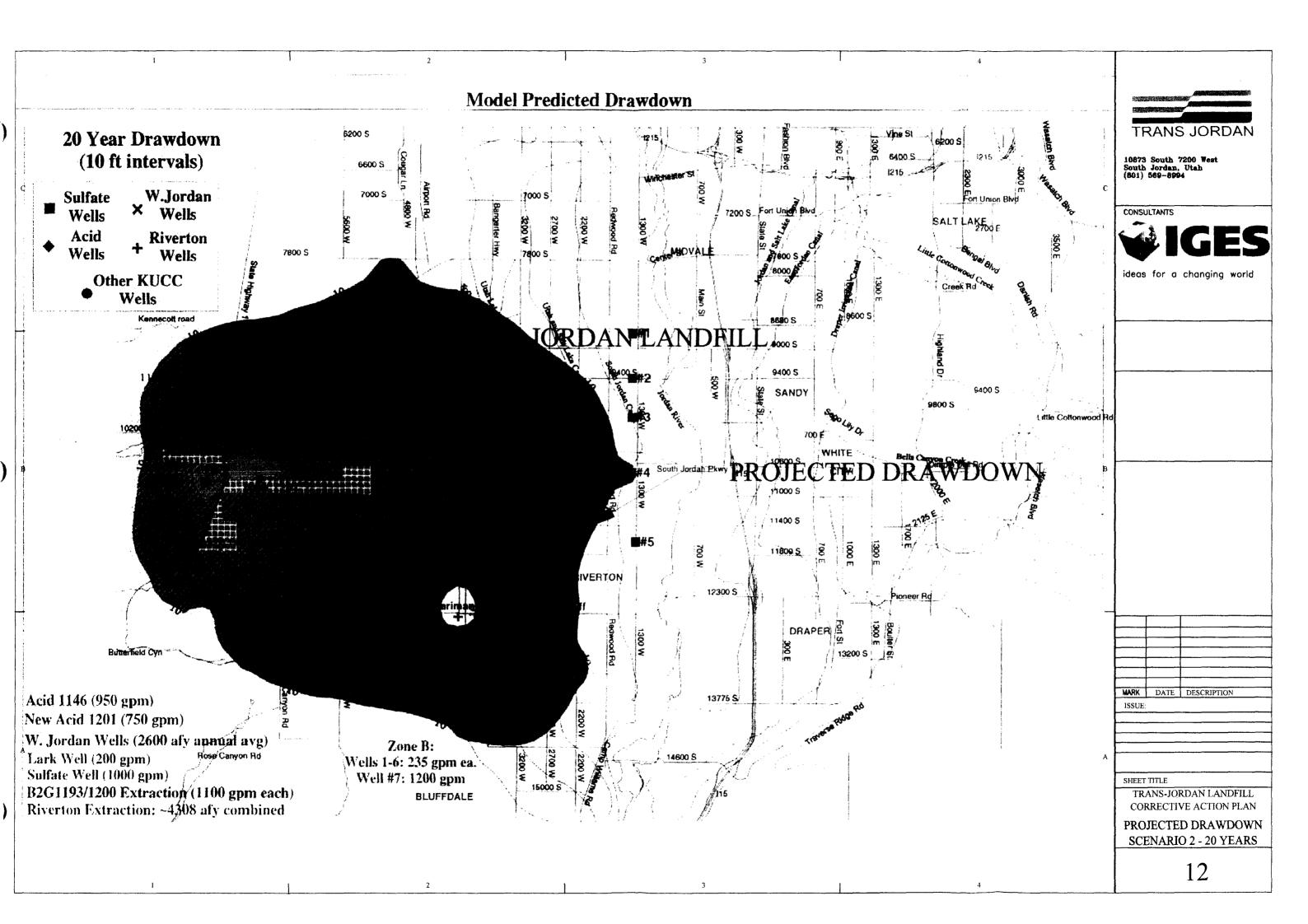


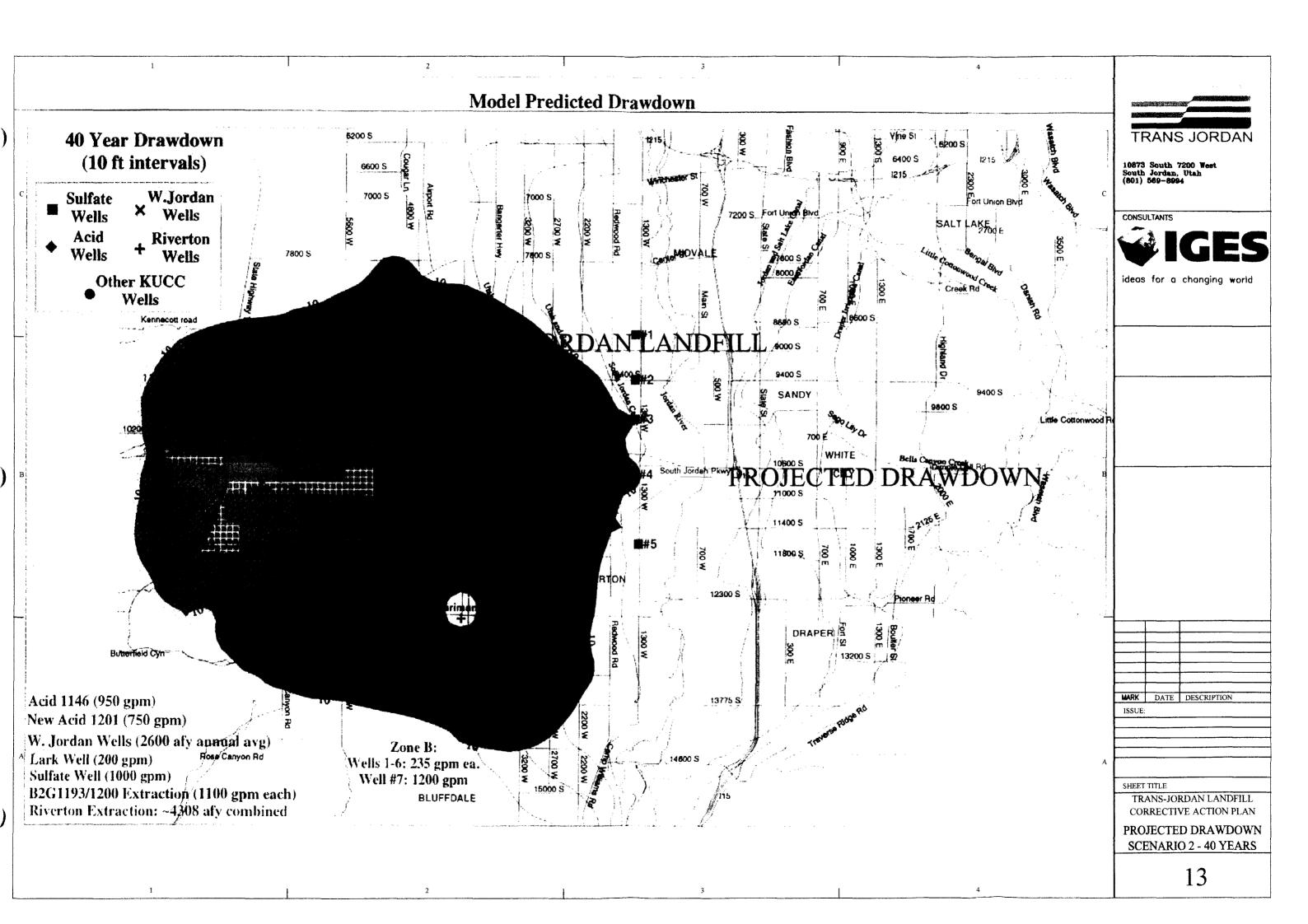












## Attachment 2



Intermountain GeoEnvironmental Services, Inc. 182 South 600 East, Suite 206, Salt Lake City, Utah 84102 Phone (801) 521-1800 | Fax (801) 521-2800

www.igesinc.com

## Trans-Jordan Landfill 2002 Groundwater Monitoring Report

IGES Job No. 00102-001

February 20, 2003

Prepared for:

#### **Trans-Jordan Cities**

c/o Mr. Dwayne Woolley 10873 South 7200 West P.O. Box 95610-0610 South Jordan, Utah 84095

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#### 1.0 INTRODUCTION

#### 1.1 PURPOSE AND SCOPE OF WORK

The purpose of this report is to present the results of recent groundwater analysis, including groundwater chemistry, depth to water and direction of flow under the Trans Jordan Landfill (TJL). This report summarizes any statistical changes that may have occurred during 2002. The period of review for this assessment is generally limited to the readings over the past year; however, the statistical assessment extends through the entire history of the sampling rounds.

The scope of work performed for this assessment includes a review of the 2002 sampling data, a statistical assessment of the readings, and the preparation of this report.

The recommendations contained in this report are subject to the limitations presented in the "Limitations" section of this report.

#### 1.2 PROJECT DESCRIPTION

TJL is a municipal solid waste landfill located at 10873 South 7200 West, South Jordan, Utah, in Salt Lake County. TJL is located in Section 15, Township 3 South, Range 2 West.

TJL currently has one up gradient and three down gradient monitoring wells on the property that are utilized for groundwater monitoring and sampling. The up gradient well is identified as TJMW-2 while the down gradient wells are TJMW-3, TJMW-4 and TJMW-5. These sampling wells were originally installed based on the predominant groundwater flow being west to east. However, the construction of a groundwater cutoff wall completed by Kennecott Utah Corporation (KUC), several years of below average precipitation, and down gradient water usage all have contributed to the drop in water levels and have altered the groundwater gradient at the site. Because of these activities and possible other unknown conditions, the TJL monitoring wells are drying up and the groundwater gradient appears to be trending south. The Groundwater Contour Maps and Field Sampling Data Summary Sheets located in Appendix D show the apparent flow direction and groundwater elevations over time.

TJMW-1 was originally installed as an up gradient well but is currently no longer used for groundwater sampling. However, groundwater elevations are measured in TJMW-1 quarterly. This well did not accurately represent general background water conditions as compared to other historic groundwater quality data from monitoring wells in the area. TJMW-2 was installed in January of 1995 and has since served as the up gradient well for the landfill.

In 2002, four sampling rounds were completed for TJMW-4 and TJMW-5. One sampling round was completed for TJMW-2 and no rounds were completed for TJMW-3. TJMW-2 dried up and could not be sampled during the final three rounds in 2002 and TJMW-3 dried up and could not be sampled at all during the year 2002. The dates, wells sampled and analysis performed for these rounds are summarized below:

Table 1 - Summary of 2002 Groundwater Sampling Events

Sampling Date	Well(s) Sampled	Analysis Performed
3/05/02	TJMW-2,	Complete
	TJMW-4 & TJMW-5	
6/28/02	TJMW-4 & TJMW-5	Complete
9/24/02	TJMW-4 & TJMW-5	Complete
12/10/02	TJMW-4 & TJMW-5	Complete

The results of the analyses performed on the groundwater samples were reviewed and constituents of concern were identified. To aid in identifying constituents of concern, the following steps were implemented in our assessment:

- Step 1 Identify constituents with laboratory detectable concentrations for each of the wells.
- Step 2 Perform ANOVA statistical assessments on groundwater quality data for each constituent identified in Step 1, comparing down gradient to up gradient wells.

- Step 3 Identify constituents with higher down gradient concentrations than upgradient for data sets identified as ANOVA significant in Step 2.
- Step 4 Identify constituents of concern, i.e., those identified in Step 3 with concentrations higher than the Groundwater Protection Standards.
- Step 5 Perform confidence interval analyses on constituents of concern identified in Step 4.

The following sections of the report provide information on the analytical results for each well, a discussion of the statistical evaluation of the analytical results and conclusions and recommendations based on the analytical test results, statistical evaluation and constituents of concern assessment.

### 2.0 MONITORING WELL SUMMARIES

### 2.1 MONITORING WELL TJMW-2

Monitoring Well TJMW-2 is completed to a depth of 455 feet below ground surface (Elevation 4814.16) and was drilled and installed in January 1995. The well serves the TJL as the site up gradient well.

### Summary of Analytical Results for 2002 sampling period

One groundwater-sampling round was completed for this well in 2002. This sampling round was performed on March 5, 2002 and constituted the 34<sup>th</sup> round for this particular well.

Several constituents have historically had concentrations higher than the groundwater protection standards presented on the list of Constituents for Detection Monitoring (Table R315-308-4 in The Manual for Solid Waste Permitting and Management Rules R315-301 through 320, Utah Administrative Code). That trend continues and many of the constituents remain consistent with historical values. However, Arsenic, which measured slightly above the standard (0.05 mg/l) on one occasion in 2000 and did not measure above the standard in 2001 was non-detectable (<0.005 mg/l) in 2002. Also, for the first time, a hit of Tetrachloroethylene (Tetrachloroethene) was obtained. A concentration of 0.0036 mg/l was detected, which is below the groundwater protection standard of 0.005 mg/l.

The list of constituents having measured concentrations at or above the groundwater protection standards for Well TJMW-2 in the single 2002 sampling round are listed in the following table:

Well TJMW-2 (continued on the next page)

Constituent	Groundwater Protection Standard (mg/l)	Sampling Round 34 (mg/l)
Beryllium	0.004	0.086
Cadmium	0.005	0.390
Cobalt	2.0	3.6
Copper	1.3	21.0

Constituent	Groundwater Protection Standard (mg/l)	Sampling Round 34 (mg/l)
Lead	0.015	0.024
Nickel	0.1	5.4
Thallium	0.002	0.0056
Zinc	5.0	31.0

### 2.2 MONITORING WELL TJMW-3

Monitoring well TJMW-3 is completed to a depth of 319 feet below ground surface (Elevation 4710.77) and was drilled and installed in December of 1995 as a down gradient well.

### Summary of Analytical Results for 2002 sampling period

Due to the lack of water in well TJMW-3, analytical testing could not be conducted. However, just enough water was present to obtain a water level reading. The groundwater levels are shown in The Field Data Sampling Summary Sheet in Appendix D.

As a summary for well TJMW-3, during the 2001 analytical results three of the heavy metals analyzed were above the groundwater protection standard. It should be noted that throughout the well's history, as many as 15 constituents have been above the reporting limits. Several of these constituent levels dropped below the standards over time and an overall trend of these constituents reducing with time was apparent.

### 2.3 MONITORING WELL TJMW-4

Monitoring well TJMW-4 is completed to a depth of 365 feet below ground surface and was drilled and installed in November of 1997 as a down gradient well.

### Summary of Analytical Results for 2002 sampling period

Four groundwater-sampling rounds were completed for this well in 2002. Dates for the sampling rounds are summarized in Table 1. These sampling rounds constitute the 16<sup>th</sup>, 17<sup>th</sup> 18<sup>th</sup> and 19<sup>th</sup> rounds for this particular well.

Based on the results of the 2002 chemical analysis, two of the heavy metals analyzed were above the groundwater protection standards, Lead and Thallium. In general, Lead was lower than previous years but still exceeded the standards. Thallium was just slightly above this standard with one reading of 0.0021 mg/l in March of 2002, while the other rounds were all non-detect (<0.001 mg/l). Arsenic, Chromium and Nickel, which were above the groundwater protection standards in 2001, did not exceed the standards in 2002.

No organic constituents were observed above the groundwater protection standards in Well TJMW-4.

The list of constituents having measured concentrations at or above the groundwater protection standards for Well TJMW-4 in the 2002 sampling rounds are listed in the following table:

Well TJMW-4

Constituent	Groundwater Protection Standard (mg/l)	Sampling Round 16 (mg/l)	Sampling Round 17 (mg/l)	Sampling Round 18 (mg/l)	Sampling Round 19 (mg/l)
Lead	0.015	0.061	0.065	0.044	0.033
Thallium	0.002	0.0021	< 0.001	< 0.001	< 0.001

### 2.4 MONITORING WELL TJMW-5

Monitoring well TJMW-5 is completed to a depth of 365 feet below ground surface (Elevation 4705.9) and was drilled and installed in July of 1998 as a down gradient well.

### Summary of Analytical Results for 2002 sampling period

Four groundwater-sampling rounds were completed for this well in 2002. Dates for the sampling rounds are summarized in Table 1. These sampling rounds constitute the 16<sup>th</sup>, 17<sup>th</sup>, 18<sup>th</sup> and 19<sup>th</sup> rounds for this particular well.

Based on the results of the 2002 chemical analysis, two of the heavy metals are above the groundwater protection standards, Lead and Thallium. In general, Lead was lower than previous years but still exceeded the standards. Thallium was just slightly above the

standard (0.002 mg/l) with one reading of 0.0021 mg/l in March of 2002, while the other rounds were lower than groundwater protection standards or non-detect (<0.001 mg/l). Arsenic, which measured above the standard in 2001, measured below the standard in 2002.

Of the organic constituents analyzed, Tetrachloroethene continued to be above the groundwater protection standard in Well TJMW-5 and has generally increased from historical values. Also, 1,1,1-Trichloroethane, even though it is below the groundwater protection standard, has also shown an increase over time.

The list of constituents having measured concentrations at or above the groundwater protection standards for Well TJMW-5 in the 2002 sampling rounds are listed in the following table:

### Well TJMW-5

Constituent	Groundwater Protection Standard (mg/l)	Sampling Round 16 (mg/l)	Sampling Round 17 (mg/l)	Sampling Round 18 (mg/l)	Sampling Round 19 (mg/l)	
Lead	0.015	0.10	0.045	0.087	0.022	
Thallium	0.002	0.0021	< 0.001	0.0017	< 0.001	
Tetrachloroethene	0.005	0.016	0.011	0.015	0.014	

### 3.0 STATISTICAL EVALUATION OF ANALYTICAL RESULTS

The statistical analysis was performed on all constituents returning a measurable concentration in any of the 2002 sampling rounds. Statistical analyses recommended by the EPA (1989, 1992) were performed on groundwater quality data for monitoring wells TJMW-2 (background) TJMW-3, TJMW-4 and TJMW-5 (down gradient). Further statistical analysis of Tetrachloroethene concentrations observed in well TJMW-5 was performed since it was reported above the groundwater protection standards and was not observed in the up gradient well at similar concentrations.

The "Sanitas" software package was used to perform the statistical assessment of the data. Sanitas is a statistical package that follows the EPA process and performs the type of analysis allowed. A flowchart depicting the steps used in the statistical analyses is presented as Plate 1 of Appendix A.

Generally, the analysis completed for the constituents was an interwell Parametric Analysis of Variance (ANOVA). Where the data for a particular constituent had greater than 15% non-detects, a non-parametric ANOVA was completed.

Several cases were encountered where outliers in the data were encountered. Removal of these points would change the data from a non-normal or non-log normal distribution to a normal or log normal distribution. This type of distribution is more appropriate for a statistical assessment. However, EPA recommends that where sufficient reason for removal of the outliers is not available, the data should be kept in the assessment. Since there was no evidence to support the removal of collected data, none of the identified outlier data was removed from the statistical assessment.

Several constituents had results that were ANOVA significant, indicating that the down gradient wells had a statistically different distribution than the up gradient well. A summary table presenting the ANOVA significant results of all constituents with measurable concentrations is presented in Appendix A. Time series graphs for all constituents in this summary table are presented in Appendix B of this report. A review of the data for the constituents listed was completed to identify any unusual characteristics and any suspicious data was checked against the original records.

To continue progressing towards identifying constituents of concern, the time series graphs in Appendix B were also used to compare concentrations in the down gradient wells to the up gradient well for those constituents identified as being ANOVA significant. The following ANOVA significant constituents were identified as having higher measured concentrations down gradient than up gradient in the 2002 sampling rounds:

- Nitrate
- Bicarbonate
- Calcium
- Potassium
- Arsenic
- Barium
- 1,1 Dichloroethene
- Tetrachloroethene
- 1,1,1 Trichloroethane
- Trichloroflouromethane
- Dichlorodiflouromethane

To define the constituents of concern, the constituents listed above were compared to the groundwater protection standards. Only Tetrachloroethene in TJMW-5 was above the groundwater protection standards and was identified as a constituent of concern.

Confidence intervals were performed on this constituent over the last 10 sampling rounds. Based on the Non-Parametric Confidence Interval analysis, the compliance limit of 0.005 mg/l for Tetrachloroethene was not exceeded. The results of this analysis are included in Appendix C.

### 4.0 GROUNDWATER ELEVATIONS

Groundwater elevations in the four monitoring wells have been decreasing over the past few years. As noted previously, wells TJMW-2 and TJMW-3 have dried up to the point that analytical samples can no longer be taken. Also mentioned previously, it is suspected that an up gradient groundwater cutoff wall completed by Kennecott Utah Corporation (KUC), several years of below average precipitation, and down gradient water usage all have contributed to the drop in water levels.

It should also be noted that Kennecott will begin an extensive groundwater recovery/remediation program immediately adjacent to the Trans Jordan site. This process will have an even greater impact to the groundwater elevations and direction of flow at the site. As the impacts from the Kennecott project become evident, modifications to the Trans Jordan groundwater monitoring program will be necessary.

A summary of the change in groundwater elevation and water column height in the wells are provided below:

Summary of Groundwater Elevations and Water Column Heights

Well Identification	Initial GW Elevation	Initial Height of Water Column	Dec. 2002 GW Elevation	Dec. 2002 Height of Water Column
TJMW-1	4852.96	38.80	4828.32	14.16
TJMW-2	4747.27	34.50	4712.82	DRY
TJMW-3	4741.04	30.27	4710.09	DRY
TJMW-4	4728.28	21.85	4710.59	4.16
TJMW-5	4727.09	21.19	4710.44	4.54

These new groundwater elevations for 2002 reflect a general decrease of over three feet from the past year with groundwater elevations in the wells having dropped between 17 and 34 feet since the initial well construction. As noted previously, these new groundwater elevations reflect a change in the direction of the groundwater flow from generally east to generally south, which impacts the up gradient/down gradient well status and ultimately the statistical analysis. Plots of the groundwater contours and complete records, including graphs, of the groundwater elevations over time in all the wells are included in Appendix D.

### 5.0 CONCLUSIONS AND RECOMMENDATIONS

In general, organic constituents that have been a concern in the past appear to be decreasing in concentration with time with the exception being Tetrachloroethene. Tetrachloroethene continues to be measured in concentrations above groundwater protection standards in well TJMW-5 and has trended slightly higher in recent years.

Based on a confidence interval analysis of the ten most recent measured concentrations of Tetrachloroethene in well TJMW-5, concentrations currently do not exceed the groundwater protection standard of 0.005 mg/l. However, based on our projections, it is likely the confidence interval for Tetrachloroethene in well TJMW-5 will be exceeded with the next sampling round.

As discussed, Lead and Thallium are metals that have measurable concentrations above groundwater protection standards in the down gradient wells. However, measured concentrations of these metals and others are consistently higher in the up gradient well or are not ANOVA significant and therefore are not considered to be caused by TJL.

Nitrate, Bicarbonate, Calcium, Potassium, 1,1 Dichloroethene, 1,1,1 Trichloroethane, Trichlorofluoromethane and Dichlorodiflouromethane were observed to have higher measured concentrations down gradient than up gradient but either they did not exceed the groundwater protection standards or are not currently regulated under the groundwater protection standards.

The Sampling and Analysis Plan has not been finalized due to the dropping water levels and their impact to the groundwater monitoring system.

### 6.0 LIMITATIONS

The recommendations contained in this report are based, in part, on historical sampling data that was performed by others and on ongoing data collected by IGES. IGES assumes no liability as to the accuracy of the historical data used in this assessment.

This report was prepared in accordance with the generally accepted standard of practice at the time this report was written. No warranty, expressed or implied, is made.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding this report, please do not hesitate to contact us at your convenience (801) 521-1800.

Respectfully submitted,

IGES, Inc.

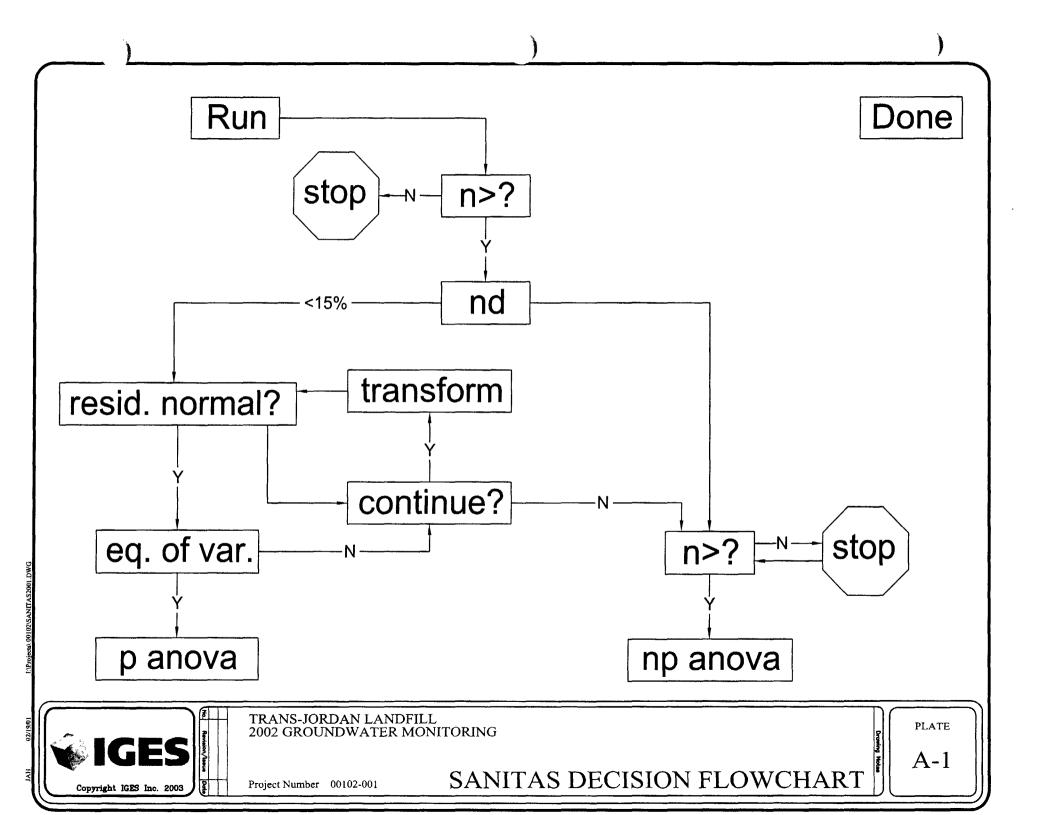
Kent A. Hartley, P.E.

Associate

Brett D. Mickelson, P.E.

Principal

# APPENDIX A



# Analysis of V jance Summary

Date: 2/20/03, 4:22 PM

Facility: Trans-Jordan-Cities/

Data File: 2002gw					Client: IGES
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:												
;	Constituent	CAS#	Well	Calculated	Critical	Signif.	Alpha	Bg Wells	Transform	ANOVA Sig.	Alpha	Method
!	Ammonia (mg/l)	7664-41-7	MW-3	-33.006	15.247	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
i	Ammonia (mg/l)	7664-41-7	MW-4	-36.433	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
	Ammonia (mg/l)	7664-41-7	MW-5	-33.960	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
	Nitrate (mg/l)	n/a	MW-3	42.976	15.126	Yes	0.01667	MW-2	n/2	Yes	0.05	NP (non-detects)
	Nitrate (mg/l)	n/a	MW-4	49.187	15.395	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
İ	Nitrate (mg/l)	n/a	MW-5	24.837	15.126	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
	Bicarbonate (mg/I)	n/a	MW-3	40.605	15.247	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
	Bicarbonate (mg/l)	n/a	MW-4	23.944	15.498	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
	Bicarbonate (mg/l)	п/а	MW-5	60.000	15.498	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
	pH (pH-units)	n/a	MW-3	45.684	15.247	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (equality of variance)
	pH (pH-units)	n/2	MW-4	45.583	15.498	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (equality of variance)
	pH (pH-units)	n/2	MW-5	33.000	15.498	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (equality of variance)
	Calcium (mg/l)	n/a	MW-3	2.47	0.571	Yes	0.01667	MW-2	square root(x)	Yes	0.05	Parametric
	Calcium (mg/l)	n/a	MW-4	1.25	0.581	Yes	0.01667	MW-2	square root(x)	Yes	0.05	Parametric
	Calcium (mg/l)	n/a	MW-5	4.79	0.581	Yes	0.01667	MW-2	square root(x)	Yes	0.05	Parametric
	Potassium (mg/l)	n/a	MW-3	2.785	15.247	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
	Potassium (mg/l)	n/a	MW-4	14.788	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
	Potassium (mg/l)	п/а	MW-5	36.371	15.498	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
	Chloride (mg/l)	n/a	MW-3	-40.075	15.247	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
i	Chloride (mg/l)	n/a	MW-4	-28.786	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
	Chloride (mg/l)	n/a	MW-5	-15.536	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
	Sodium (mg/l)	n/a	MW-3	6.344	15.247	No	0.01667	MW-2	n/a	No	0.05	NP (normality)
	Sodium (mg/l)	n/a	MW-4	-3.810	15.498	No	0.01667	MW-2	n/a	No	0.05	NP (normality)
	Sodium (mg/l)	п/а	MW-5	-2.393	15.498	No	0.01667	MW-2	n/a	No	0.05	NP (normality)
	iron (mg/l)	7439-89-6	MW-3	-2.33	1.43	No	0.01667	MW-2	square root(x)	Yes	0.05	Parametric
ĺ	Iron (mg/l)	7439-89-6	MW-4	-1.27	1.46	No	0.01667	MW-2	square root(x)	Yes	0.05	Parametric
	Iron (mg/I)	7439-89-6	MW-5	-2.31	1.46	No	0.01667	MW-2	square root(x)	Yes	0.05	Parametric
	Sulfate (mg/l)	n/a	MW-3	-39.737	15.247	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
1	Sulfate (mg/l)	п/а	MW-4	-56.694	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
i	Sulfate (mg/l)	n/a	MW-5	-28.167	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
!	Magnesium (mg/l)	n/a	MW-3	-45.474	15.247	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
	Magnesium (mg/l)	n/2	MW-4	-54.444	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
!	Magnesium (mg/l)	n/a	MW-5	-24.361	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
i	TDS (mg/l)	п/а	MW-3	-46.237	15.247	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
i	TDS (mg/l)	n/a	MW-4	-51.417	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
:	TDS (mg/l)	n/a	MW-5	-26.583	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
	Manganese (mg/l)	7439-96-5	MW-3	-42.132	15.247	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
v.8	.01. For the statistical analyses of groundwater by	IGES only.										

# Analysis of V jance Summary

Date: 2/20/03, 4:22 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data	File	- 200	12011
Data	1 110	. 200	125 VV

Constituent	CAS#	Well	Calculated	Critical	Signif.	Alpha	Bg Wells	Transform	ANOVA Sig.	Alpha	Method
Manganese (mg/l)	7439-96-5	MW-4	-40.583	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
Manganese (mg/l)	7439-96-5	MW-5	-37.139	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
TOC (mg/l)	n/a	MW-3	-1.667	15.049	No	0.01667	MW-2	n/a	No	0.05	NP (non-detects)
TOC (mg/l)	n/a	MW-4	0.667	15.049	No	0.01667	MW-2	n/a	No	0.05	NP (non-detects)
TOC (mg/l)	n/a	MW-5	12.039	15.312	No	0.01667	MW-2	n/a	No	0.05	NP (non-detects)
Arsenic (mg/l)	7440-38-2	MW-3	13.133	15.575	No	0.01667	MW-2	ti/a	Yes	0.05	NP (non-detects)
Arsenic (mg/l)	7440-38-2	MW-4	24.293	16.719	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Arsenic (mg/l)	7440-38-2	MW-5	11.285	17.011	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Barium (mg/l)	7440-39-3	MW-3	0.138	0.157	No	0.01667	MW-2	square root(x)	Yes	0.05	Parametric
Barium (mg/l)	7440-39-3	MW-4	0.263	0.16	Yes	0.01667	MW-2	square root(x)	Yes	0.05	Parametric .
Barium (mg/l)	7440-39-3	MW-5	0.109	0.16	No	0.01667	MW-2	square root(x)	Yes	0.05	Parametric
Beryllium (mg/l)	7 <b>440-41-7</b>	MW-3	-45.854	15.575	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Beryllium (mg/l)	7440-41-7	MW-4	-42.658	16.719	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Beryllium (mg/l)	7440-41-7	MW-5	-53.111	17.011	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Cadmium (mg/l)	7440-43-9	MW-3	-45.542	15.575	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Cadmium (mg/l)	7440-43-9	MW-4	-49.921	16.719	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Cadmium (mg/l)	7440-43-9	MW-5	-45.861	17.011	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Chromium (mg/l)	n/a	MW-3	-12.165	15.575	No	0.01667	MW-2	n/a	No	0.05	NP (normality)
Chromium (mg/l)	n/a	MW-4	-4.447	16.719	No	0.01667	MW-2	n/a	No	0.05	NP (normality)
Chromium (mg/l)	n/a	MW-5	-17.699	17.011	No	0.01667	MW-2	n/a	No	0.05	NP (normality)
Cobalt (mg/l)	7440 <u>48</u> -4	MW-3	-44.816	15.247	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Cobalt (mg/l)	7440-48-4	MW-4	-40.556	15.498	No	0.01667	MW-2	п/а	Yes	0.05	NP (non-detects)
Cobalt (mg/l)	7440-48-4	MW-5	-38.944	15.498	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Copper (mg/l)	7440-50-8	MW-3	-48.208	15.575	No	0.01667	MW-2	п/а	Yes	0.05	NP (equality of variance)
Copper (mg/l)	7440-50-8	MW-4	-41.553	16.719	No	0.01667	MW-2	n/a	Yes	0.05	NP (equality of variance)
Copper (mg/l)	7440-50-8	MW-5	-51.139	17.011	No	0.01667	MW-2	11/2	Yes	0.05	NP (equality of variance)
Lead (mg/l)	п/а	MW-3	-1.273	15.575	No	0.01667	MW-2	n/a	No	0.05	NP (equality of variance)
Lead (mg/l)	n/a	MW-4	1.113	16.719	No	0.01667	MW-2	n/a	No	0.05	NP (equality of variance)
Lead (mg/l)	n/a	MW-5	-17.439	17.011	No	0.01667	MW-2	n/a	No	0.05	NP (equality of variance)
Nickel (mg/l)	7440-02-0	MW-3	-41.750	15.410	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
Nickel (mg/l)	7440-02-0	MW-4	-44.778	16.831	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
Nickel (mg/l)	7440-02-0	MW-5	-54.556	16.831	No	0.01667	MW-2	n/2	Yes	0.05	NP (normality)
Silver (mg/l)	7440-22-4	MW-3	-15.172	15.575	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Silver (mg/l)	7440-22-4	MW-4	-17.371	16.719	No	0.01667	MW-2	п/а	Yes	0.05	NP (non-detects)
Silver (mg/l)	7440-22-4	MW-5	-17.929	17.011	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Thallium (mg/l)	n/a	MW-3	-19.951	15.575	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Thallium (mg/l)	n/a	MW-4	-34.181	16.719	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)

# Analysis of V jance Summary

Date: 2/20/03, 4:22 PM

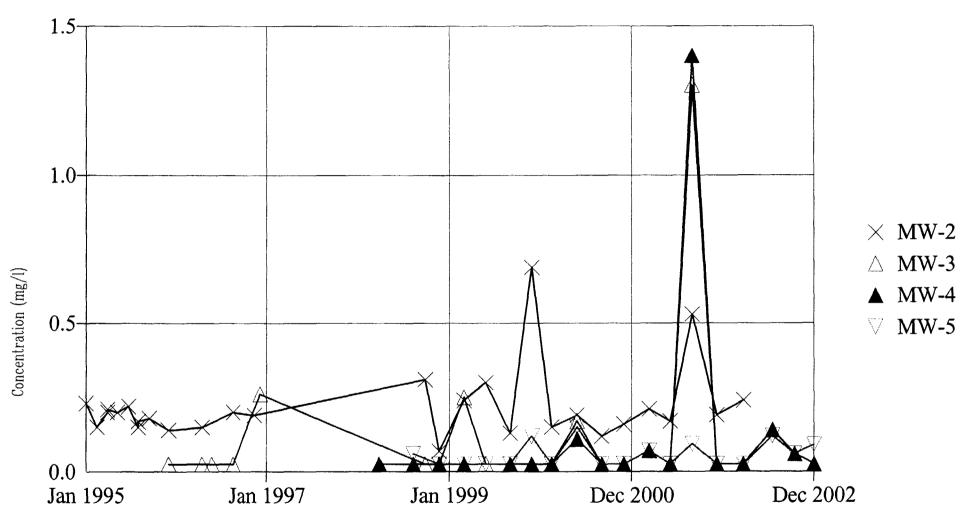
Facility: Trans-Jordan-Cities/

Data File: 2002gw

Client: IGES

Constituent	CAS#	Well	Calculated	Critical	Signif.	Alpha	Bg Wells	Transform	ANOVA Sig.	Alpha	Method
Thallium (mg/l)	n/a	MW-5	-42.159	17.011	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Vanadium (mg/l)	7440-62-2	MW-3	-15.852	15.247	No	0.01667	MW-2	n/a	No	0.05	NP (normality)
Vanadium (mg/l)	7440-62-2	MW-4	-10.450	15.498	No	0.01667	MW-2	n/a	No	0.05	NP (normality)
Vanadium (mg/l)	7440-62-2	MW-5	-17.034	15.498	No	0.01667	MW-2	n/a	No	0.05	NP (normality)
Zinc (mg/l)	7440-66-6	MW-3	-47.625	15.575	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
Zinc (mg/l)	7440-66-6	MW-4	-44.605	16.719	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
Zinc (mg/l)	7440-66-6	MW-5	-48.694	17.011	No	0.01667	MW-2	n/a	Yes	0.05	NP (normality)
Chloroethane (ug/l)	75-00-3	MW-3	-3.554	15.674	No	0.01667	MW-2	n/a	No	0.05	NP (non-detects)
Chloroethane (ug/l)	75-00-3	MW-4	-17.306	16.923	No	0.01667	MW-2	n/a	No	0.05	NP (non-detects)
Chloroethane (ug/l)	75-00-3	MW-5	-0.329	16.629	No	0.01667	MW-2	n/a	No	0.05	NP (non-detects)
1,1-Dichloroethene (ug/l)	75-35-4	MW-3	1.848	15.508	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
1,1-Dichloroethene (ug/l)	75-35-4	MW-4	0.000	16.744	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
1,1-Dichloroethene (ug/l)	75-35-4	MW-5	28.639	16.744	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Tetrachloroethene (ug/l)	127-18-4	MW-3	32.701	15.642	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Tetrachloroethene (ug/l)	127-18-4	MW-4	-1.132	17.102	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Tetrachloroethene (ug/l)	127-18-4	MW-5	46.604	16.805	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
1,1,1-Trichloroethane (ug/	71-55-6	MW-3	22.271	15.314	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
1,1,1-Trichloroethane (ug/	71-55-6	MW-4	2.063	17.415	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
1,1,1-Trichloroethane (ug/	71-55-6	MW-5	50.895	16.453	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Trichlorofluoromethane (ug	75-69-4	MW-3	36.957	15.642	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Trichlorofluoromethane (ug	75-69-4	MW-4	-1.397	17.102	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Trichlorofluoromethane (ug	75-69-4	MW-5	10.156	16.805	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Dichlorodifluoromethane (u	75-71-8	MW-3	13.407	15.141	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Dichlorodifluoromethane (u	75-71-8	MW-4	-5.785	15.995	No	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)
Dichlorodifluoromethane (u	75-71-8	MW-5	22.810	15.753	Yes	0.01667	MW-2	n/a	Yes	0.05	NP (non-detects)

# APPENDIX B



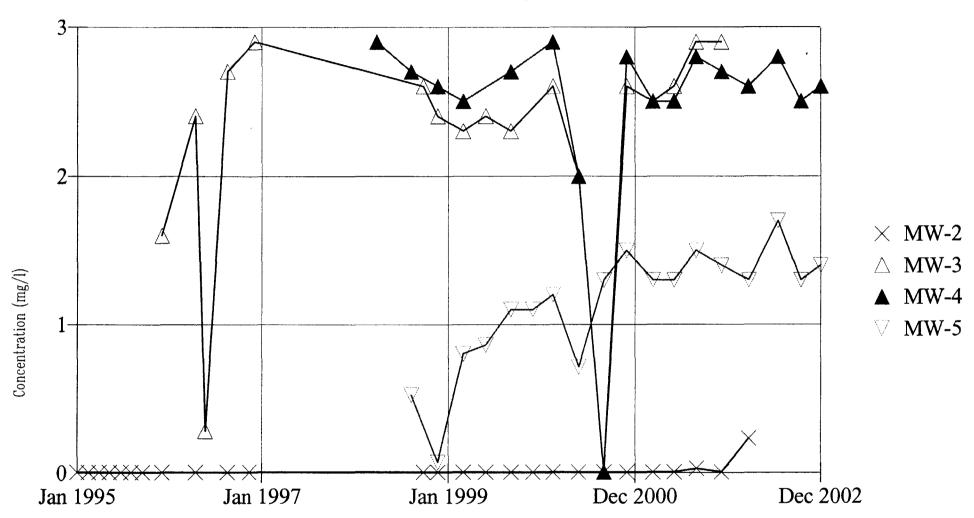
Constituent: Ammonia (mg/l)

Date: 2/20/03, 4:34 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



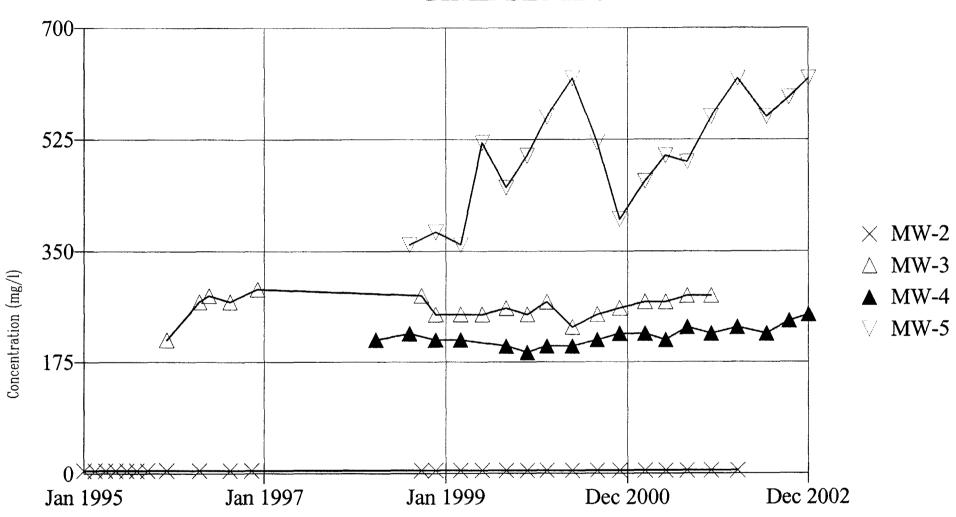
Constituent: Nitrate (mg/l)

Date: 2/20/03, 4:36 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



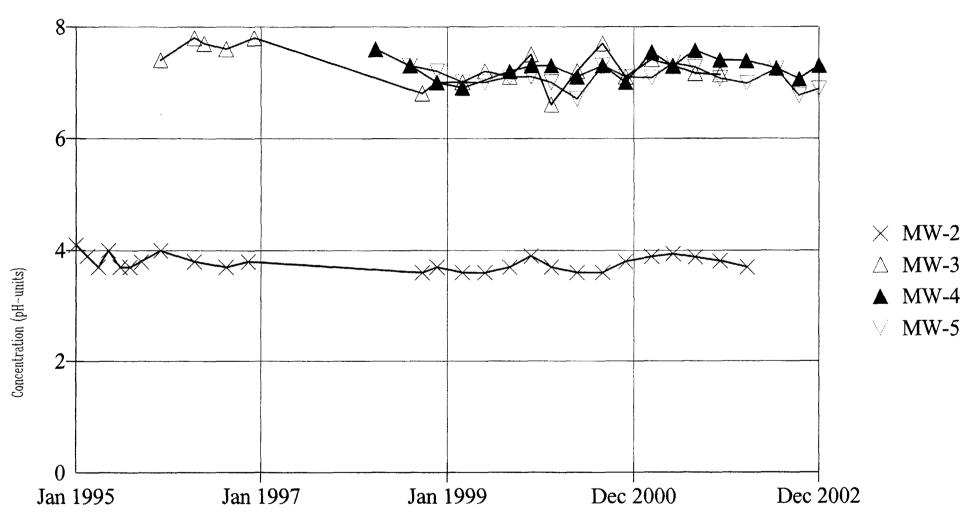
Constituent: Bicarbonate (mg/l)

Date: 2/20/03, 4:37 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



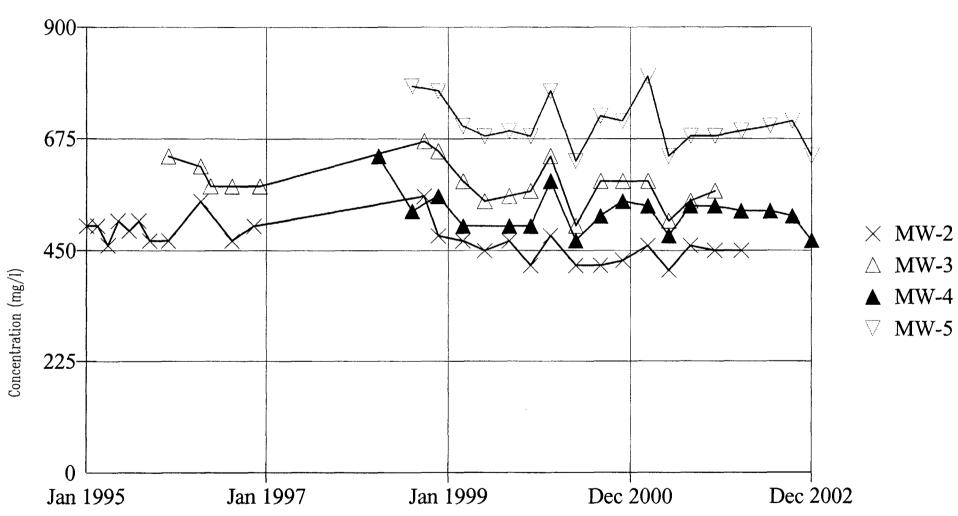
Constituent: pH (pH-units)

Date: 2/20/03, 4:38 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



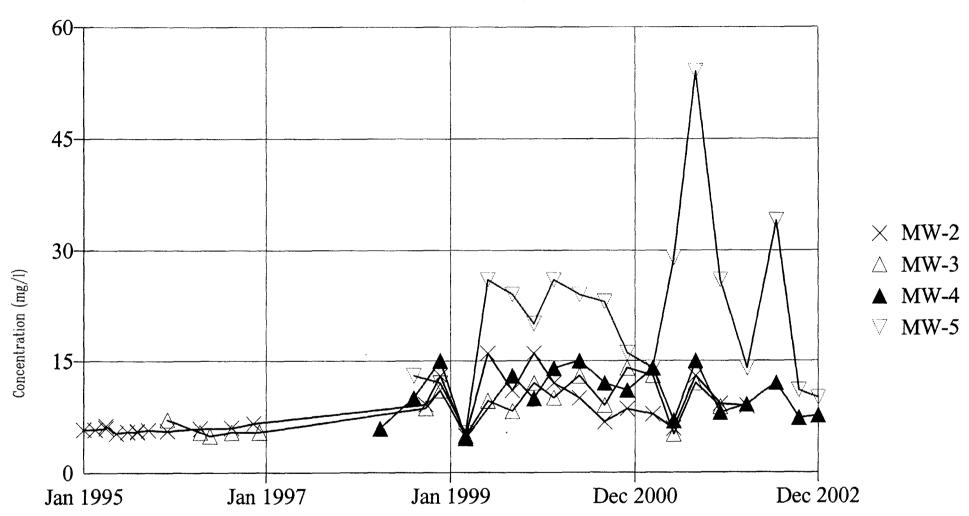
Constituent: Calcium (mg/l)

Date: 2/20/03, 4:39 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



Constituent: Potassium (mg/l)

Date: 2/20/03, 4:40 PM

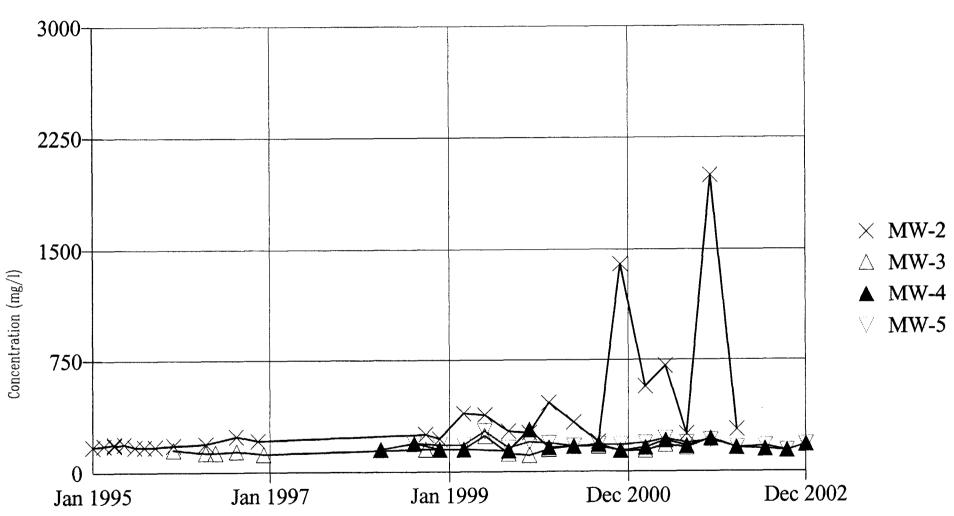
Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw

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# TIME SERIES



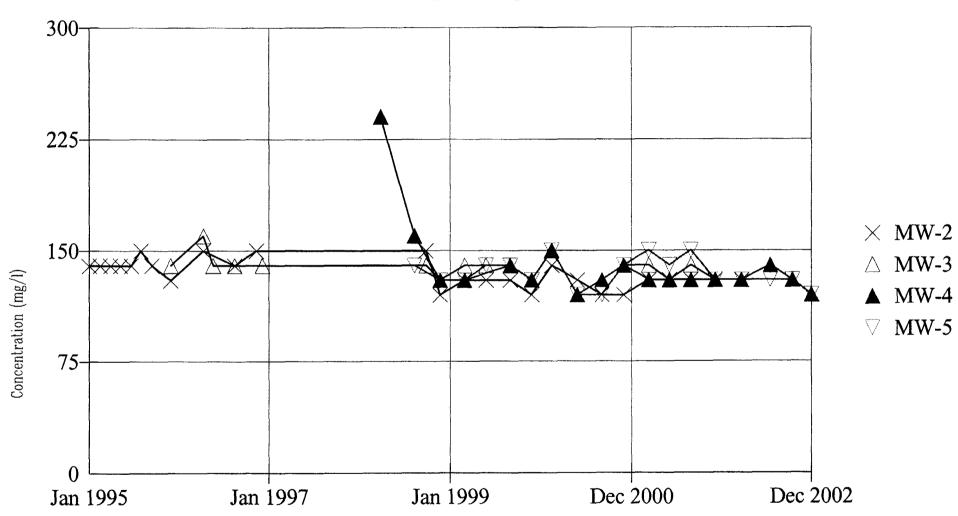
Constituent: Chloride (mg/l)

Date: 2/20/03, 4:42 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



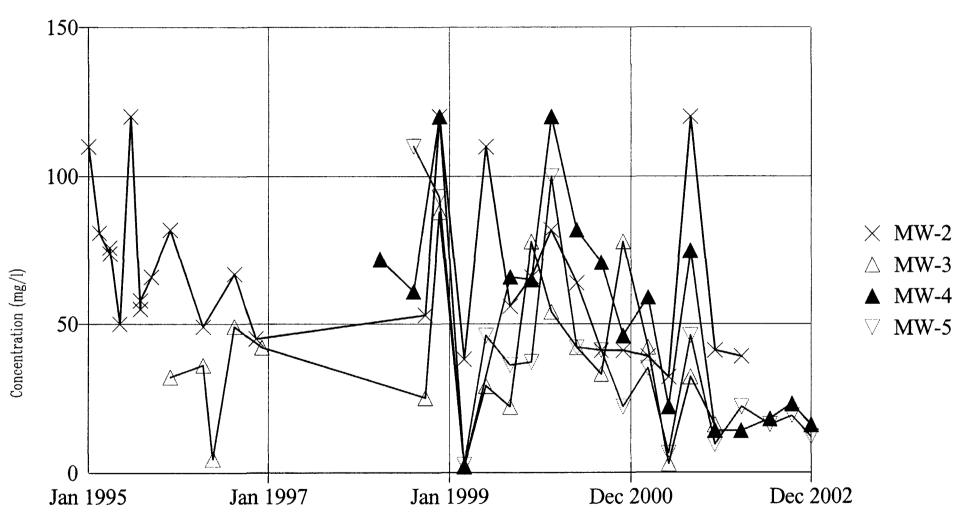
Constituent: Sodium (mg/l)

Date: 2/20/03, 4:43 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



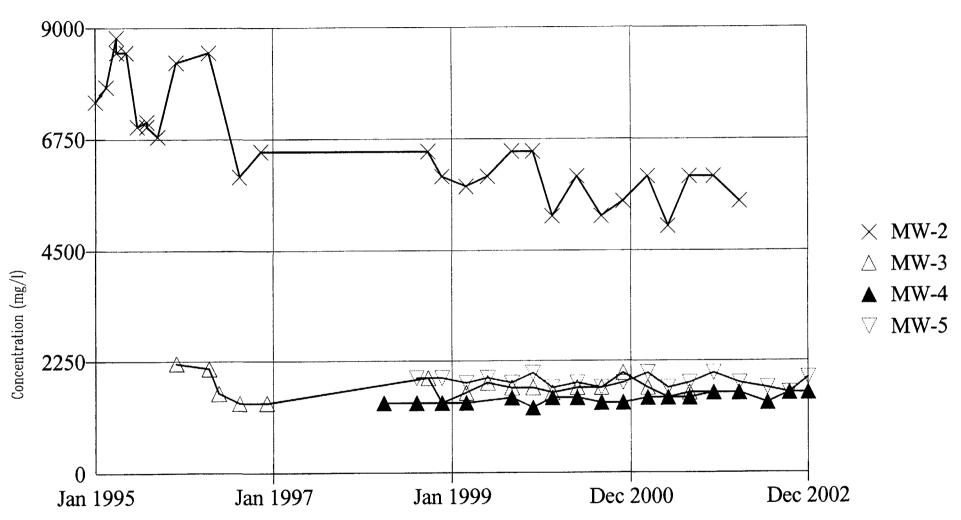
Constituent: Iron (mg/l)

Date: 2/20/03, 4:43 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



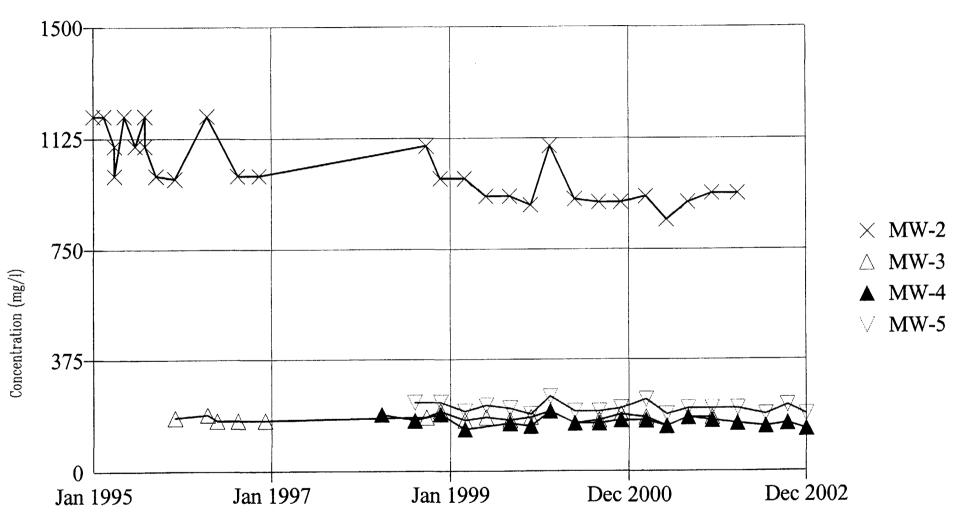
Constituent: Sulfate (mg/l)

Date: 2/20/03, 4:44 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



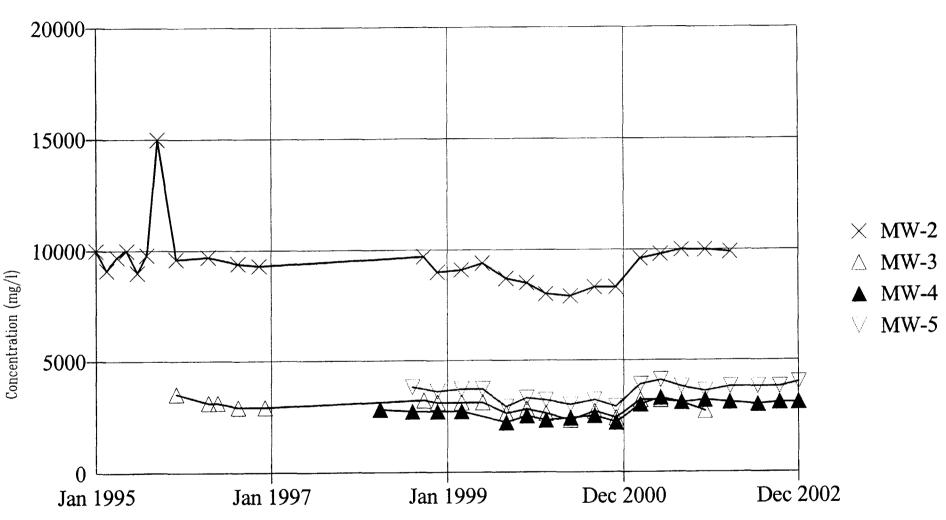
Constituent: Magnesium (mg/l)

Date: 2/20/03, 4:44 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



Constituent: TDS (mg/l)

Date: 2/20/03, 4:45 PM

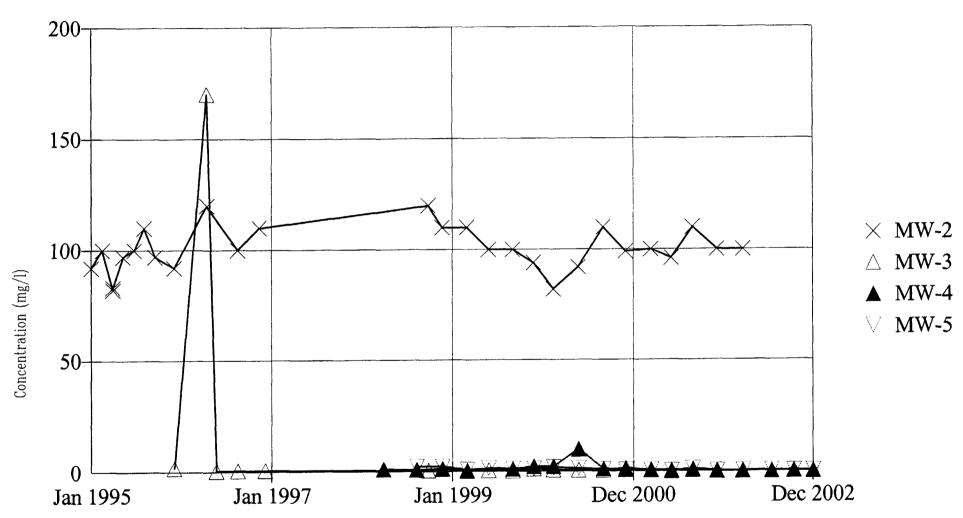
Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw

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# TIME SERIES



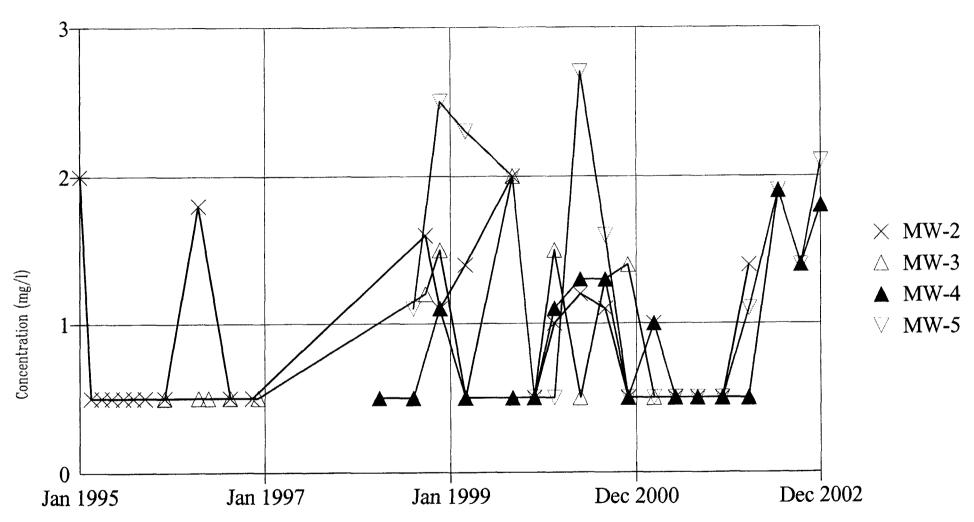
Constituent: Manganese (mg/l)

Date: 2/20/03, 4:46 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



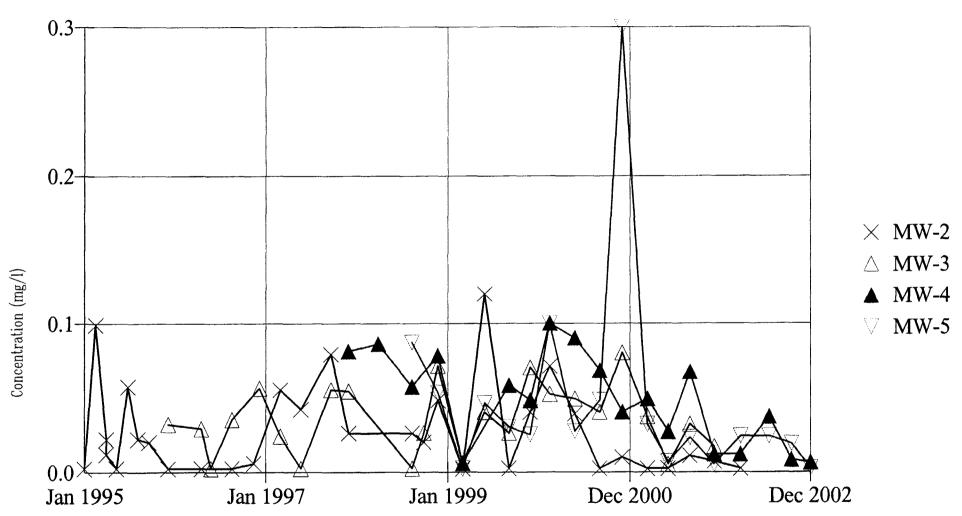
Constituent: TOC (mg/l)

Date: 2/20/03, 4:46 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



Constituent: Arsenic (mg/l)

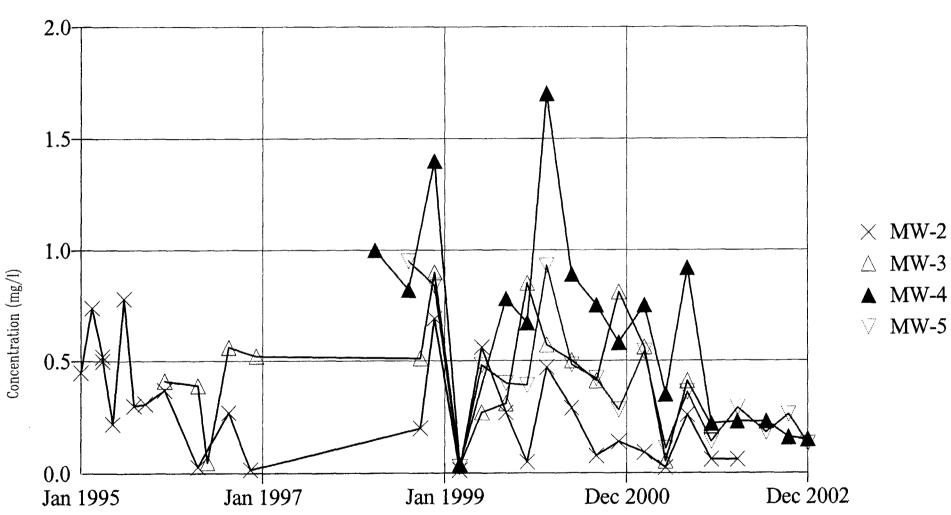
Date: 2/20/03, 4:47 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw





Constituent: Barium (mg/l)

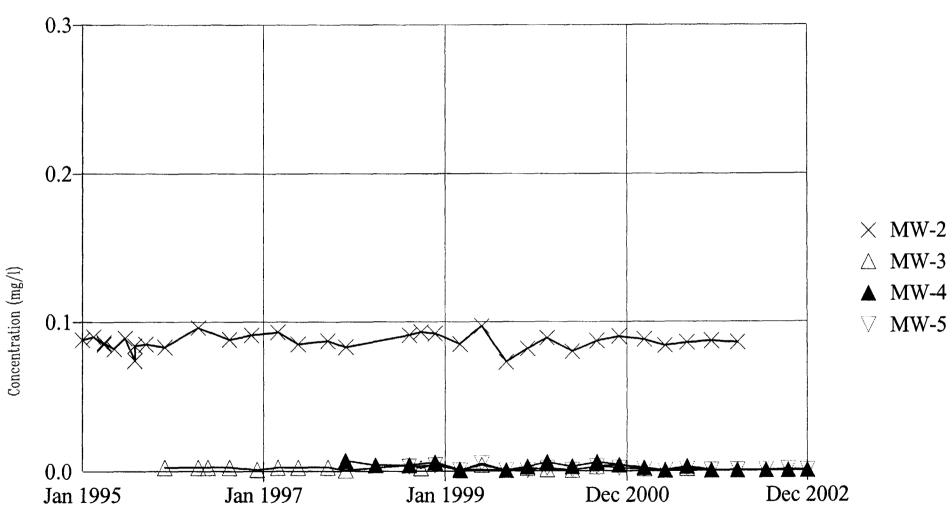
Date: 2/20/03, 4:48 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw





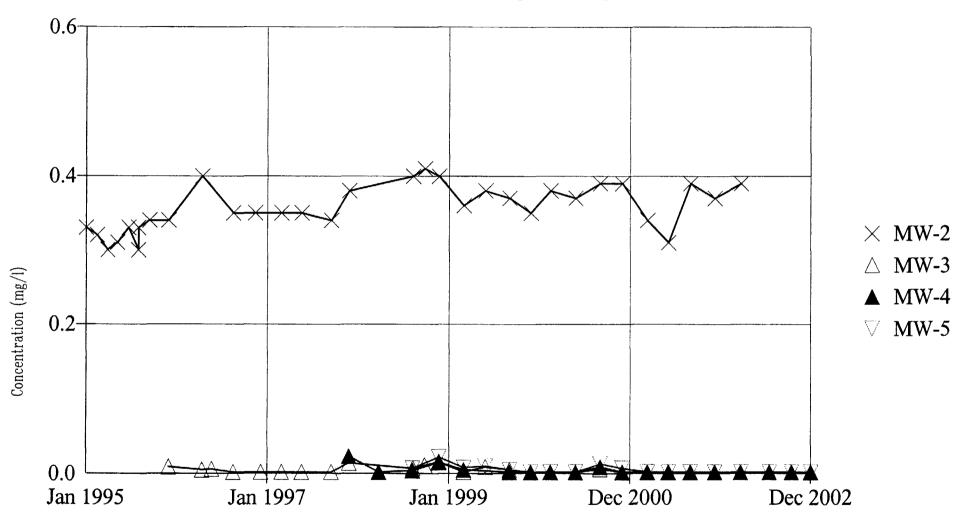
Constituent: Beryllium (mg/l)

Date: 2/20/03, 4:49 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



Constituent: Cadmium (mg/l)

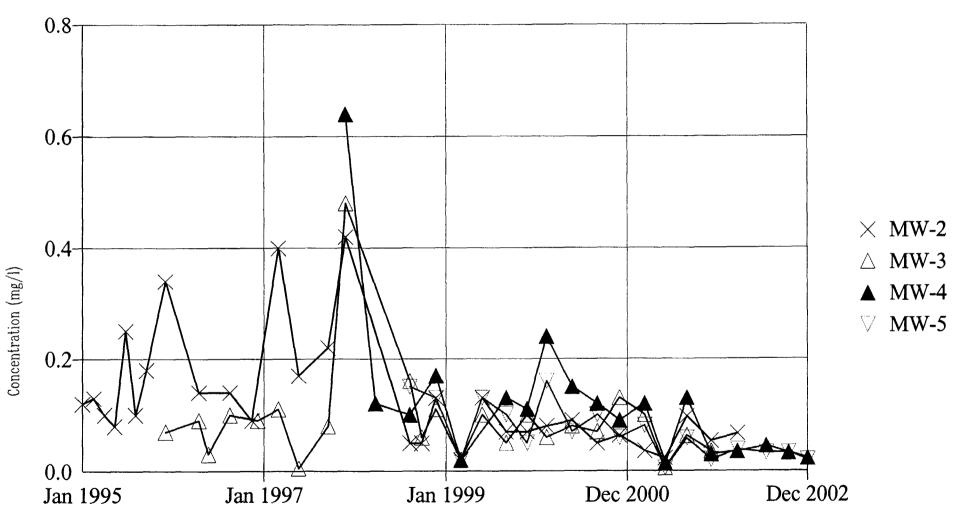
Date: 2/20/03, 4:50 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw





Constituent: Chromium (mg/l)

Date: 2/20/03, 4:51 PM

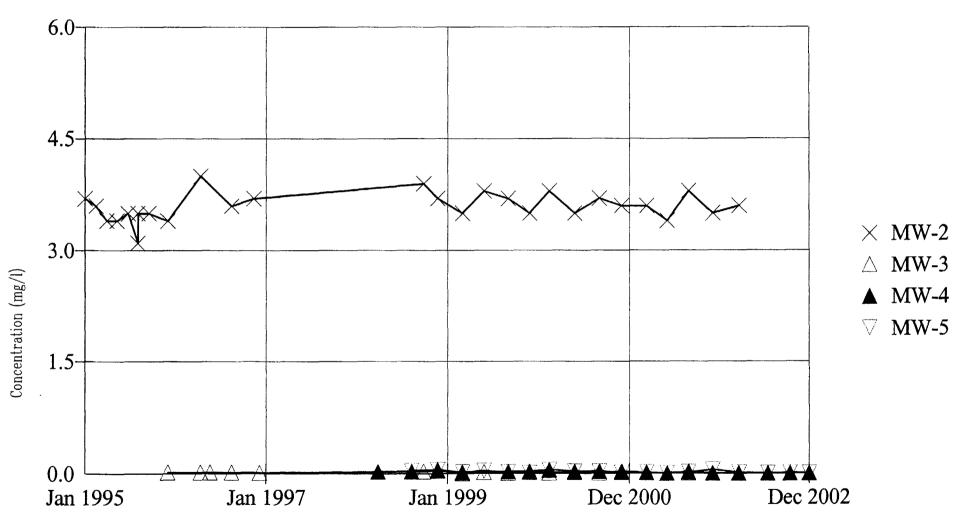
Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw

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## TIME SERIES



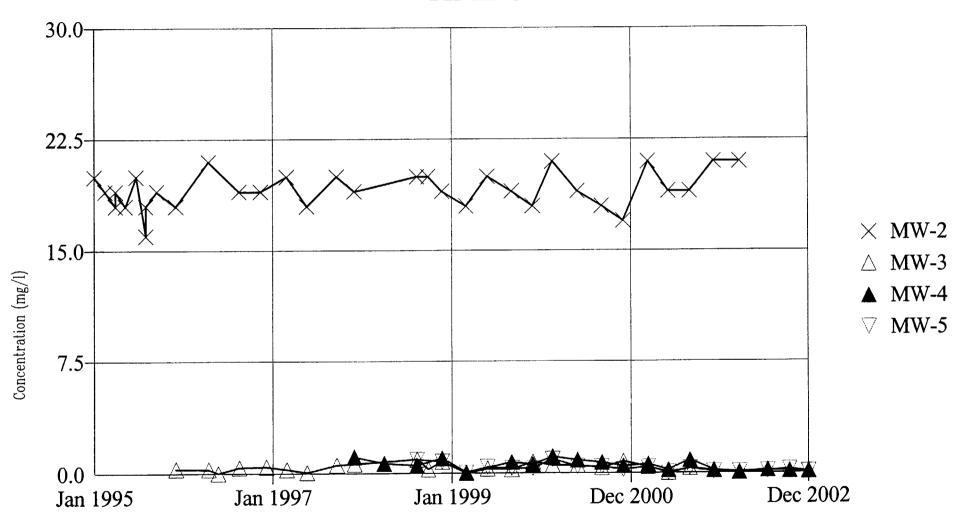
Constituent: Cobalt (mg/l)

Date: 2/20/03, 4:51 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



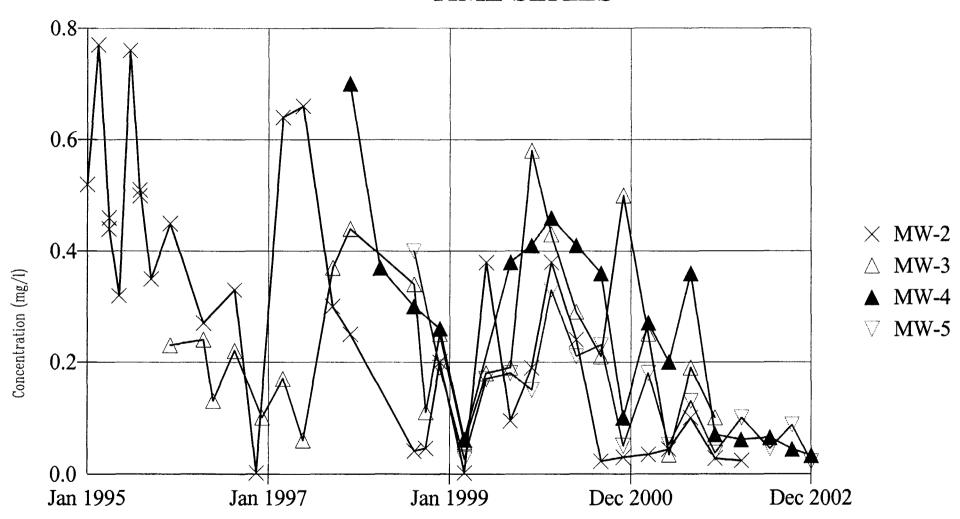
Constituent: Copper (mg/l)

Date: 2/20/03, 4:52 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



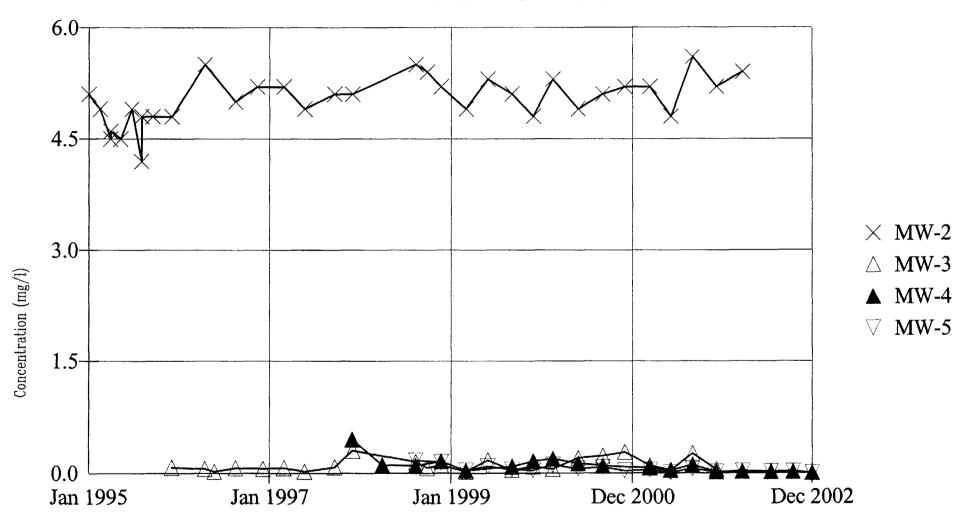
Constituent: Lead (mg/l)

Date: 2/20/03, 4:53 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



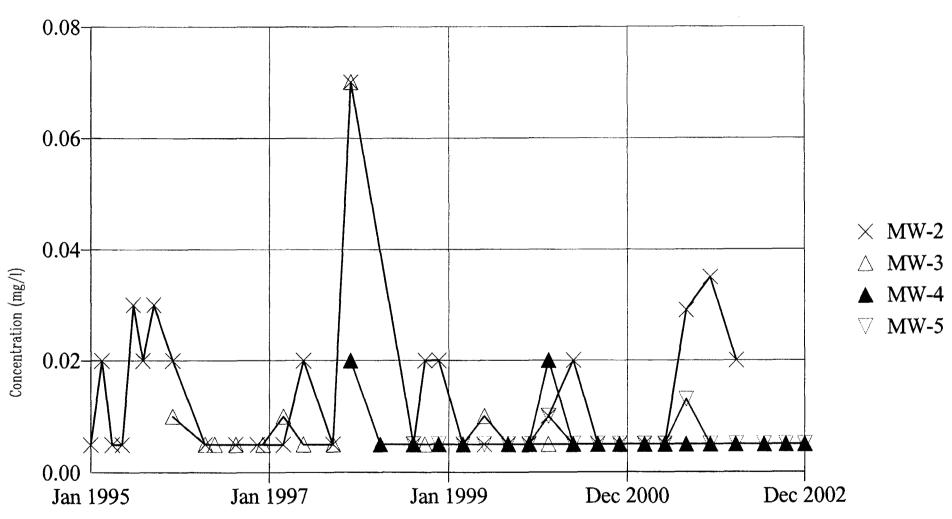
Constituent: Nickel (mg/l)

Date: 2/20/03, 4:53 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



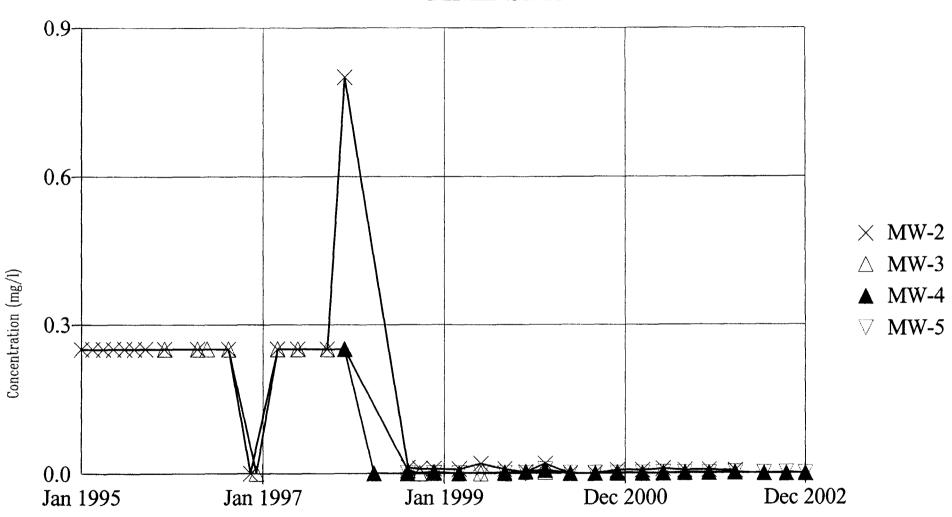
Constituent: Silver (mg/l)

Date: 2/20/03, 4:54 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



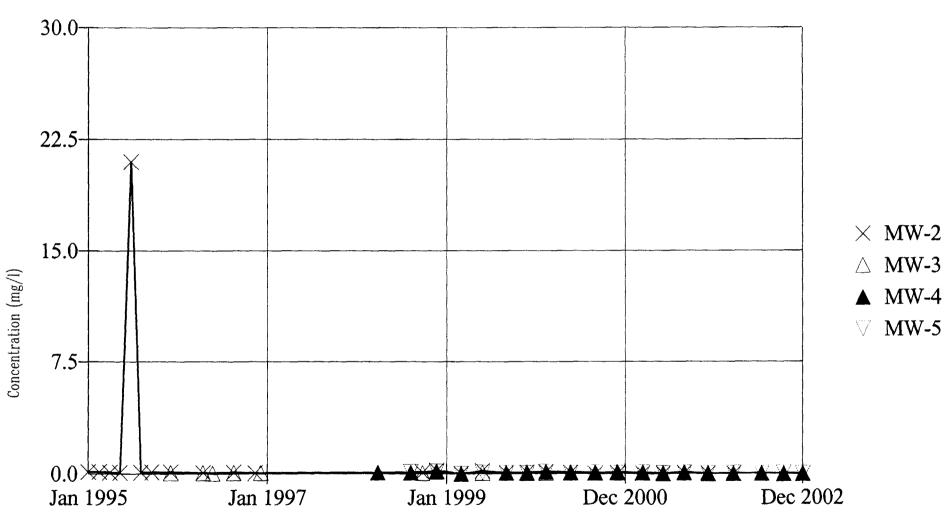
Constituent: Thallium (mg/l)

Date: 2/20/03, 4:54 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



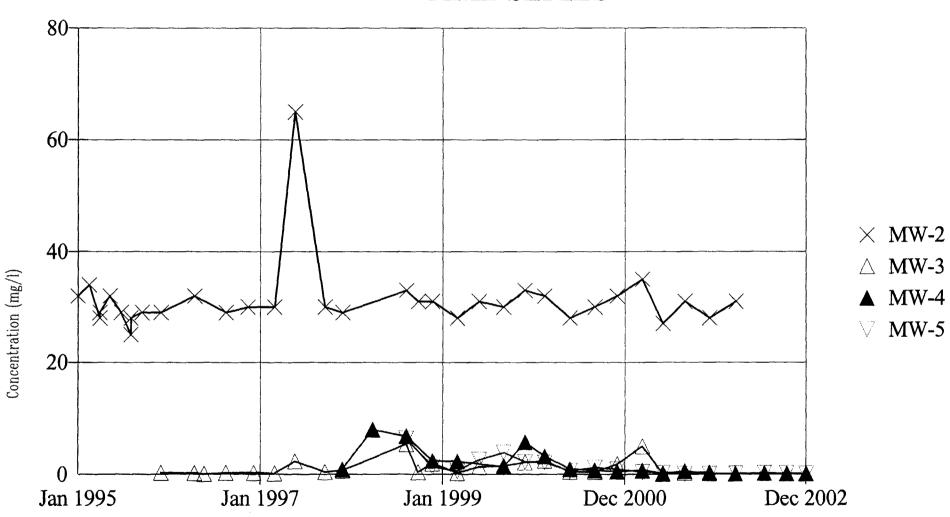
Constituent: Vanadium (mg/l)

Date: 2/20/03, 4:55 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



Constituent: Zinc (mg/l)

Date: 2/20/03, 4:56 PM

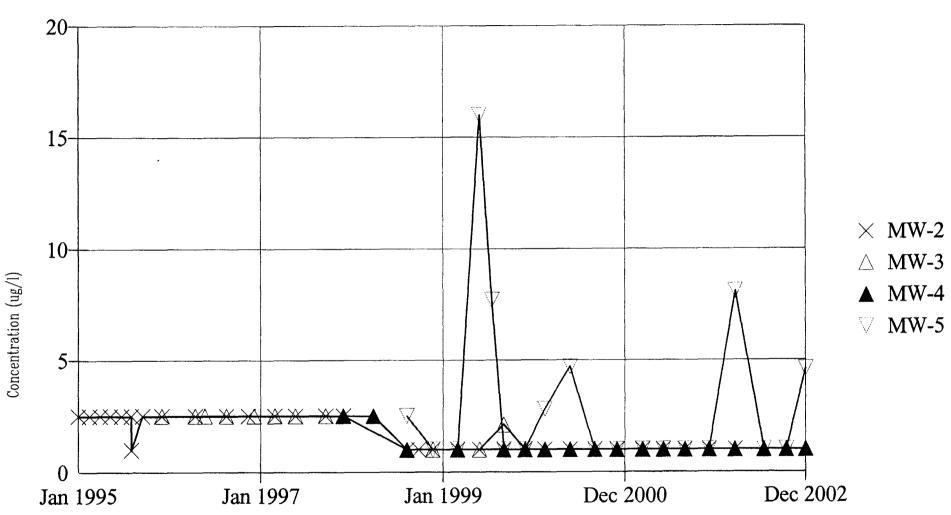
Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw

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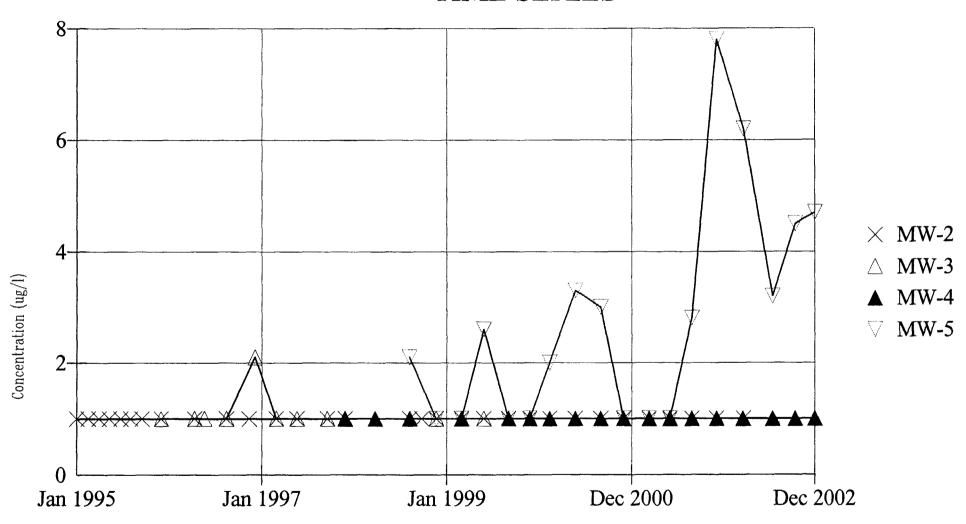
Constituent: Chloroethane (ug/l)

Date: 2/20/03, 4:57 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



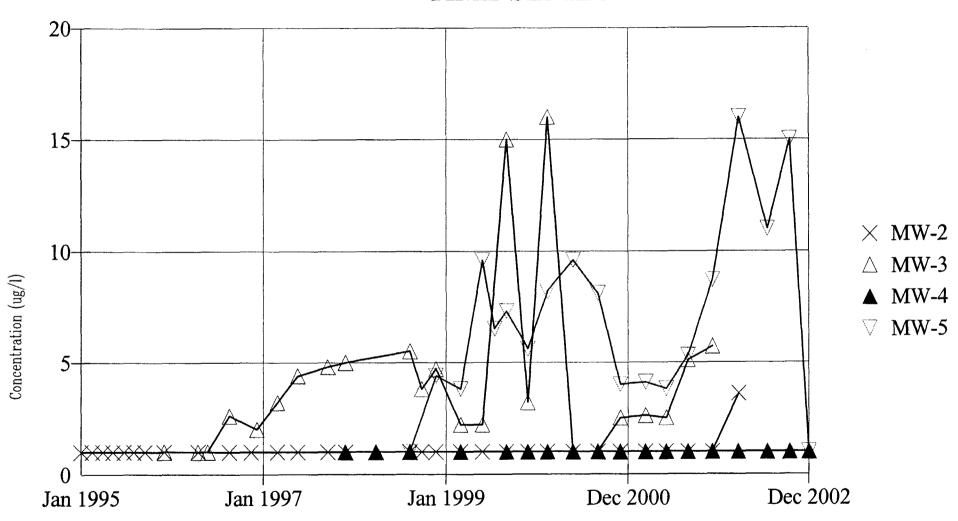
Constituent: 1,1-Dichloroethene (ug/l)

Date: 2/20/03, 4:58 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



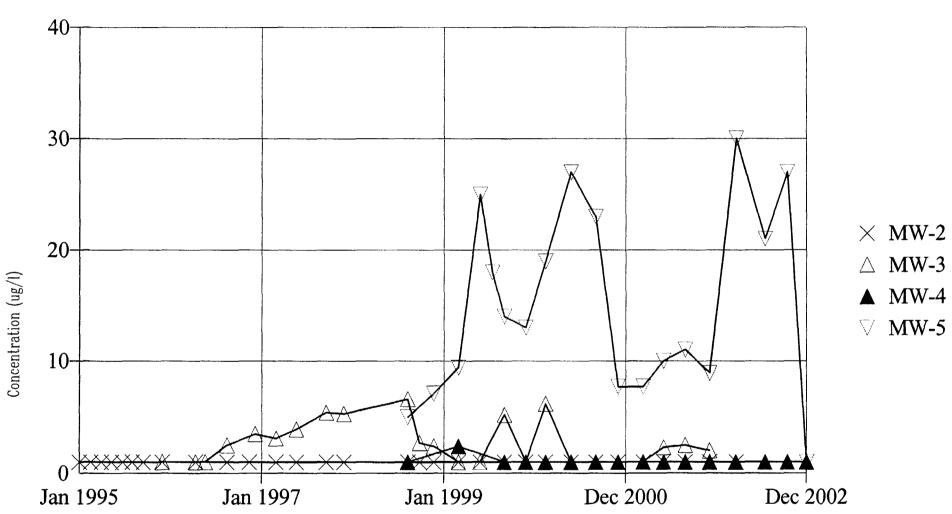
Constituent: Tetrachloroethene (ug/l)

Date: 2/20/03, 4:58 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



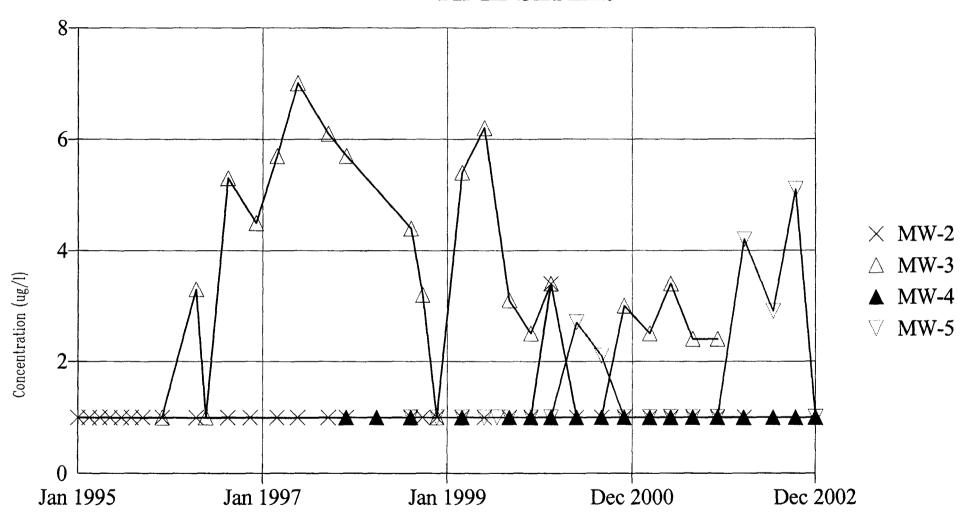
Constituent: 1,1,1-Trichloroethane (ug/l)

Date: 2/20/03, 4:59 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



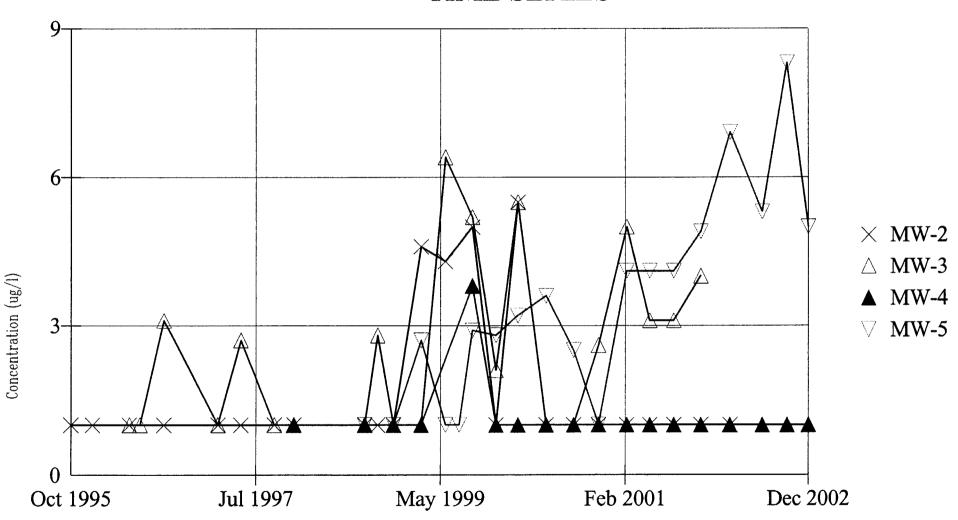
Constituent: Trichlorofluoromethane (ug/l)

Date: 2/20/03, 4:59 PM

Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw



Constituent: Dichlorodifluoromethane (ug/l)

Date: 2/20/03, 5:00 PM

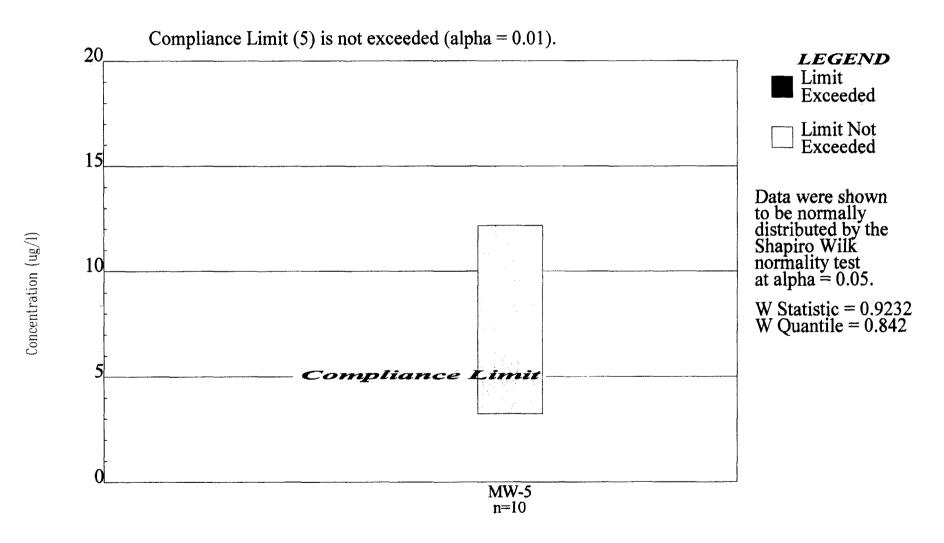
Facility: Trans-Jordan-Cities/

Client: IGES

Data File: 2002gw

# APPENDIX C

#### CONFIDENCE INTERVAL



Constituent: Tetrachloroethene (ug/l)

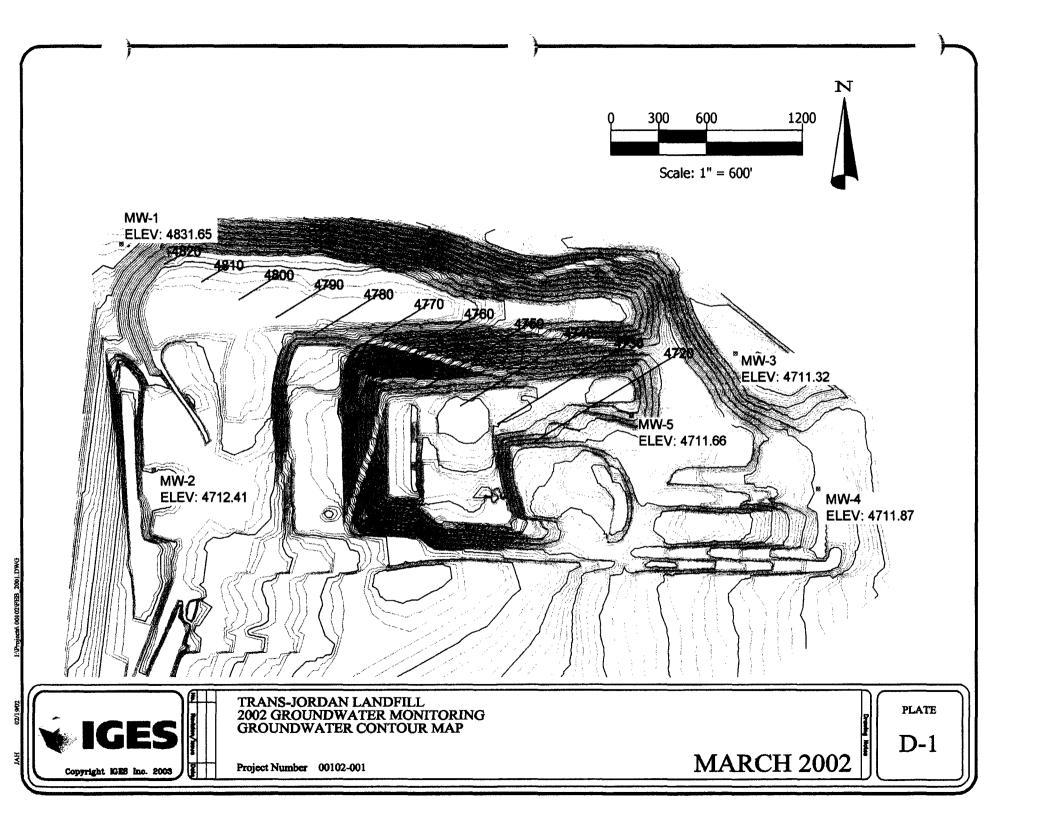
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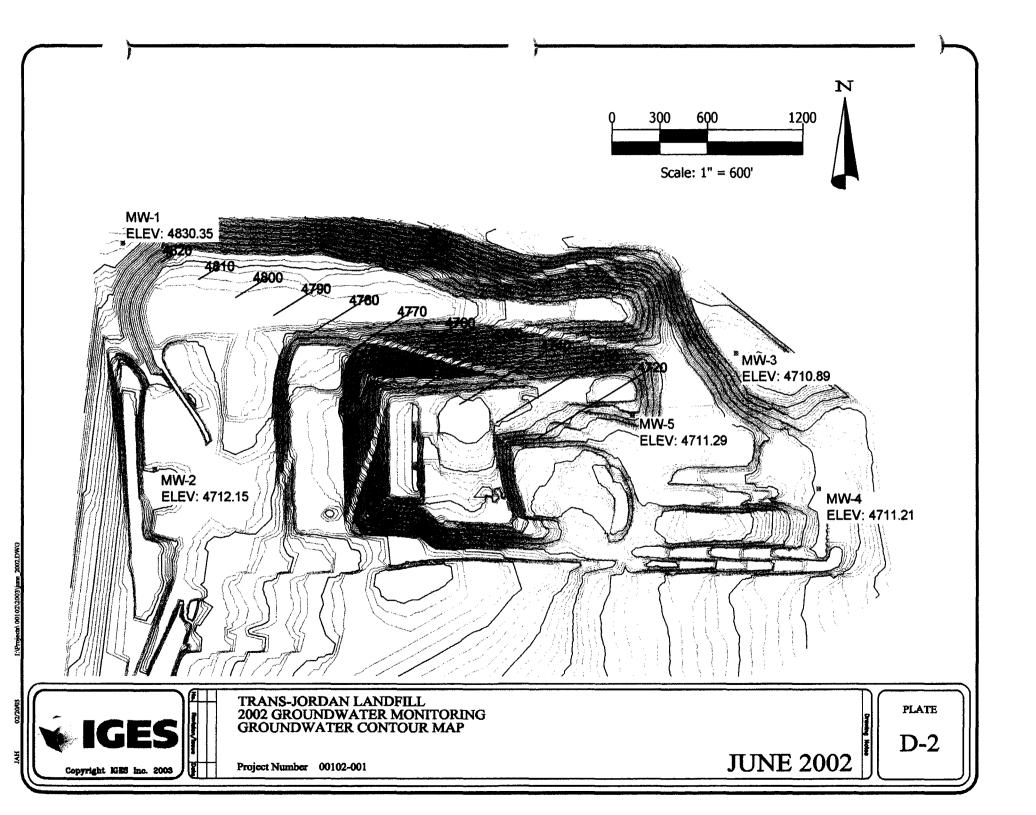
Facility: Trans-Jordan-Cities/

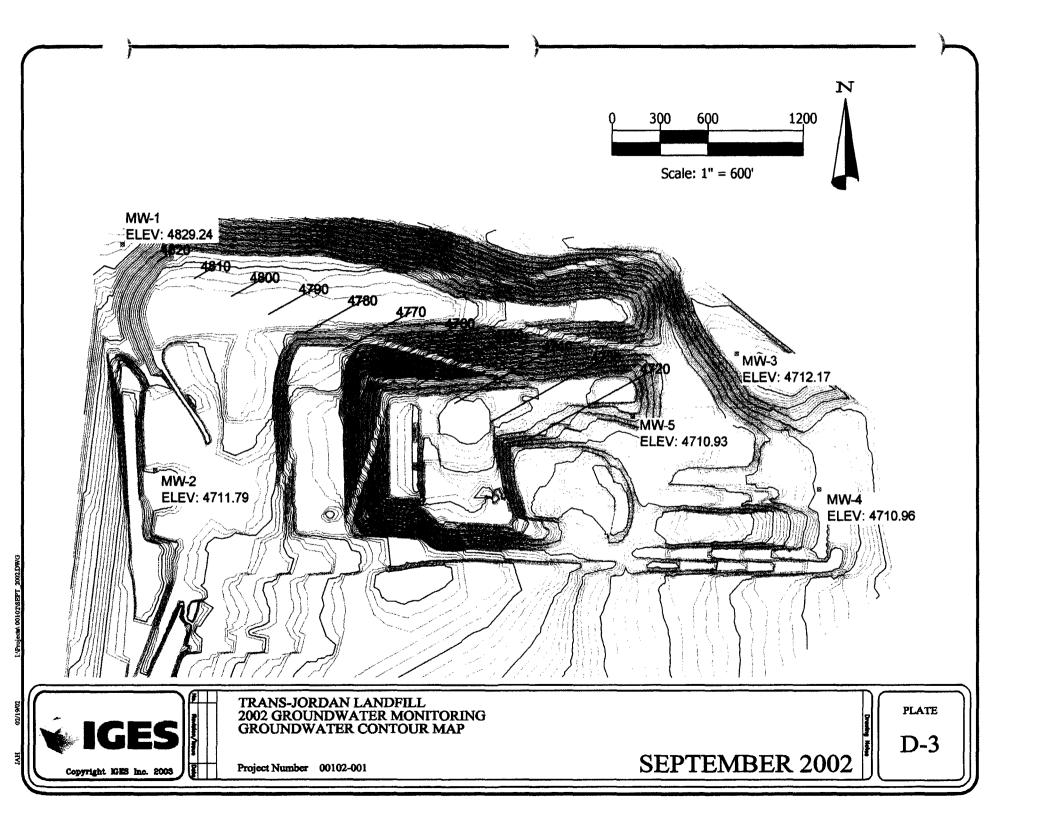
Client: IGES

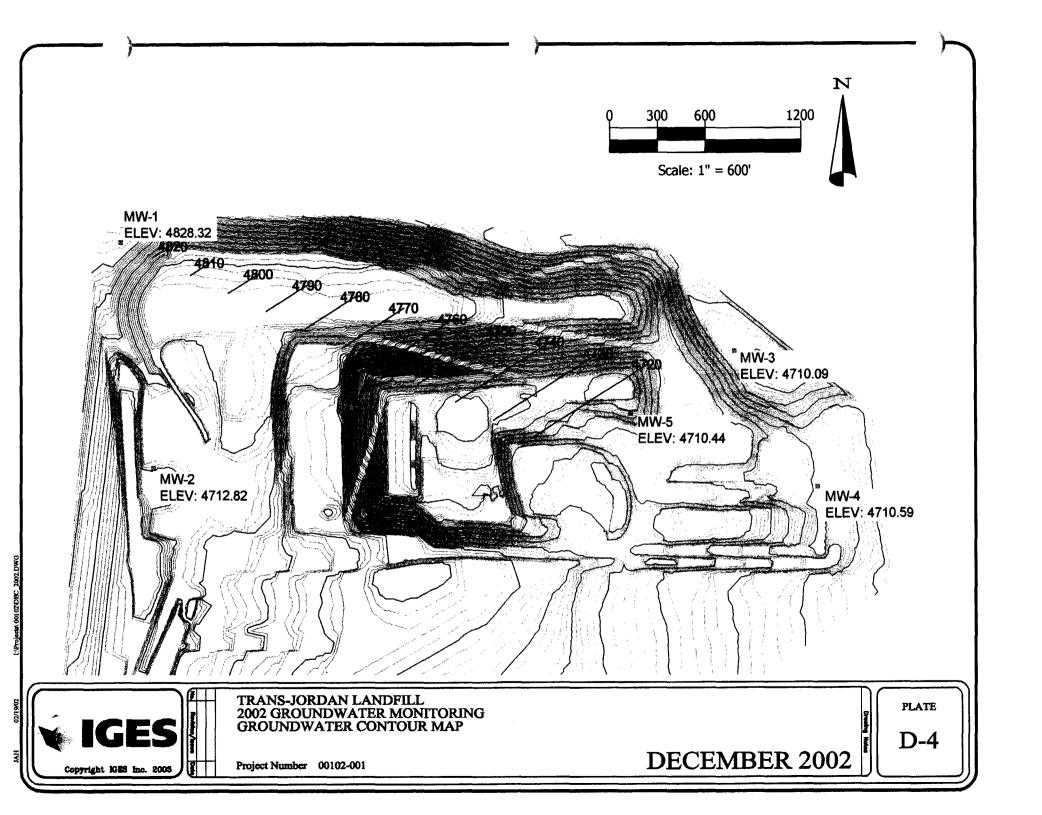
Data File: 2002gw

# APPENDIX D











 Well Identification:
 TJMW-1

 Northing:
 811,849.27

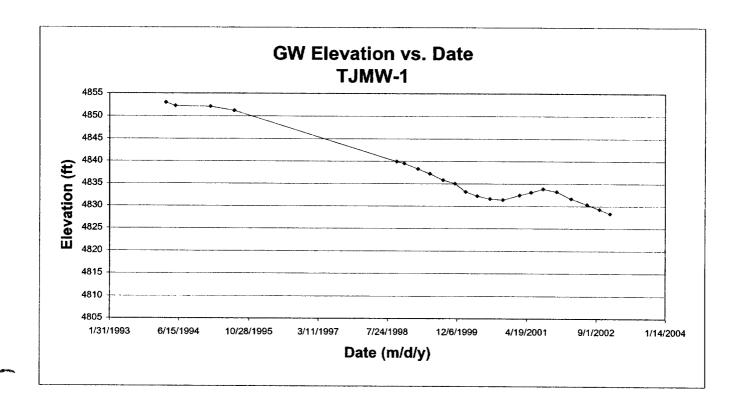
 Easting:
 1,844,080.58

 Well Casing Elevation (ft):
 5129.16

 Well Depth (ft):
 315.00

 Well Bottom Elevation (ft):
 4814.16

Depth (ft) 276.20	Elevation (ft)	of Water (ft)				Final
276.20		Or water (it)	(gals)	(pH units)	Conductivity (mmhos)	Temperature (°C
	4852.96	38.80	375	7.37	1800	12.6
276.94	4852.22	38.06	75	7.15	1600	12.3
277.10	4852.06	37.90	75	6.99	1800	11.3
278.00	4851.16	37.00	80	6.87	2000	16.7
289.21	4839.95	25.79	•	-	-	-
289.63	4839.53	25.37	-	-	-	-
290.85	4838.31	24.15	-	-	-	-
291.92	4837.24	23.08	-	-		-
293.37	4835.79	21.63	-	-	•	-
294.10	4835.06	20.90	•	-	-	-
295.98	4833.18	19.02	-	-	-	_
296.92	4832.24	18.08	-	-	-	-
297.55	4831.61	17.45	-		•	-
297.75	4831.41	17.25	-		-	-
296.73	4832.43	18.27	-	-	•	-
296.09	4833.07	18.91	-	-	-	-
295.32	4833.84	19.68	-	-	-	-
295.95	4833.21	19.05	-	-		-
297.51	4831.65	17.49				
298.81	4830.35	16.19				
299.92	4829.24	15.08				
300.84	4828.32	14.16				
	278.00 289.21 289.63 290.85 291.92 293.37 294.10 295.98 296.92 297.55 297.75 296.73 296.09 295.32 295.95 297.51 298.81 299.92	278.00 4851.16 289.21 4839.95 289.63 4839.53 290.85 4838.31 291.92 4837.24 293.37 4835.79 294.10 4835.06 295.98 4833.18 296.92 4832.24 297.55 4831.61 297.75 4831.41 296.73 4832.43 296.09 4833.07 295.32 4833.84 295.95 4833.21 297.51 4831.65 298.81 4830.35 299.92 4829.24	278.00         4851.16         37.00           289.21         4839.95         25.79           289.63         4839.53         25.37           290.85         4838.31         24.15           291.92         4837.24         23.08           293.37         4835.79         21.63           294.10         4835.06         20.90           295.98         4833.18         19.02           296.92         4832.24         18.08           297.55         4831.61         17.45           297.75         4831.41         17.25           296.73         4832.43         18.27           296.09         4833.07         18.91           295.32         4833.84         19.68           295.95         4833.21         19.05           297.51         4831.65         17.49           298.81         4830.35         16.19           299.92         4829.24         15.08	278.00         4851.16         37.00         80           289.21         4839.95         25.79         -           289.63         4839.53         25.37         -           290.85         4838.31         24.15         -           291.92         4837.24         23.08         -           293.37         4835.79         21.63         -           294.10         4835.06         20.90         -           295.98         4833.18         19.02         -           296.92         4832.24         18.08         -           297.55         4831.61         17.45         -           297.75         4831.41         17.25         -           296.73         4832.43         18.27         -           296.09         4833.07         18.91         -           295.32         4833.84         19.68         -           295.95         4833.21         19.05         -           297.51         4831.65         17.49           298.81         4830.35         16.19           299.92         4829.24         15.08	278.00         4851.16         37.00         80         6.87           289.21         4839.95         25.79         -         -           289.63         4839.53         25.37         -         -           290.85         4838.31         24.15         -         -           291.92         4837.24         23.08         -         -           293.37         4835.79         21.63         -         -           294.10         4835.06         20.90         -         -           295.98         4833.18         19.02         -         -           296.92         4832.24         18.08         -         -           297.55         4831.61         17.45         -         -           297.75         4831.41         17.25         -         -           296.73         4832.43         18.27         -         -           296.09         4833.07         18.91         -         -           295.32         4833.84         19.68         -         -           295.95         4833.21         19.05         -         -           297.51         4831.65         17.49         -     <	278.00     4851.16     37.00     80     6.87     2000       289.21     4839.95     25.79     -     -     -       289.63     4839.53     25.37     -     -     -       290.85     4838.31     24.15     -     -     -       291.92     4837.24     23.08     -     -     -       293.37     4835.79     21.63     -     -     -       294.10     4835.06     20.90     -     -     -       295.98     4833.18     19.02     -     -     -       296.92     4832.24     18.08     -     -     -       297.55     4831.61     17.45     -     -     -       297.75     4831.41     17.25     -     -     -       296.09     4833.07     18.91     -     -     -       295.32     4833.84     19.68     -     -     -       295.95     4833.21     19.05     -     -     -       297.51     4831.65     17.49     -     -     -       298.81     4830.35     16.19     -     -     -       299.92     4829.24     15.08     -     -     -     <



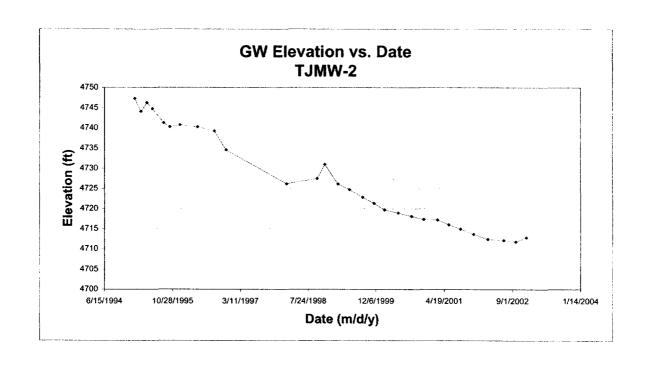


Well Identification: Northing: Easting: Well Casing Elevation (ft): Well Depth (ft): Well Bottom Elevation (ft): TJMW-2 810,469.10 1,844,286.68

5170.10 (Well Casing Extended, 2/8/00)

5167.77 455 457.33 4712.77 4712.77

Measurement	Groundwater	Groundwater	Column	Purge Volume	Final pH	Final	Final
Date (m/d/y)	Depth (ft)	Elevation (ft)	of Water (ft)	(gals)	(pH units)	Conductivity (mmhos)	Temperature (°C
1/24/1995	420.50	4747.27	34.50	350	3.89	7400	11.5
3/9/1995	423.70	4744.07	31.30	90	3.45	6900	12.9
4/21/1995	421.50	4746.27	33.50	85	3.57	8300	16.7
5/31/1995	423.00	4744.77	32.00	85	3.61	7400	17.6
8/22/1995	426.50	4741.27	28.50	80	3.6	6900	19.8
10/5/1995	427.50	4740.27	27.50	90	3.48	7200	13.7
12/20/1995	427.00	4740.77	28.00	75	3.71	6600	11.2
4/29/1996	427.50	4740.27	27.50	75	3.51	7200	16.5
8/30/1996	428.50	4739.27	26.50	70	3.53	4900	22.8
11/25/1996	433.20	4734.57	21.80	60	3.42	3600	10.0
2/15/1998	441.57	4726.20	13.43	45	4.04	6900	14.5
9/28/1998	440.28	4727.49	14.72	48	3.87	6950	15.0
11/23/1998	436.75	4731.02	18.25	30	3.96	6900	14.8
3/1/1999	441.62	4726.15	13.38	30	3.96	6900	14.8
5/26/1999	443.05	4724.72	11.95	45	3.96	6925	15.2
8/30/1999	444.92	4722.85	10.08	30	3.71	6640	15.3
11/22/1999	446.43	4721.34	8.57	50	3.86	7015	11.7
2/8/2000	450.37	4719.73	6.96	36	3.68	6920	14.4
5/18/2000	451.16	4718.94	6.17	33	3.61	6920	15.0
8/24/2000	451.98	4718.12	5.35	50	3.61	6710	15.8
11/20/2000	452.77	4717.33	4.56	38	3.76	6620	12.8
2/28/2001	452.88	4717.22	4.45	50	3.51	6580	13.7
5/21/2001	454.07	4716.03	3.26	47	3.59	6110	14.7
8/15/2001	455.15	4714.95	2.18	44	3.64	5950	16.1
11/20/2001	456.45	4713.65	0.88	9 (dry)	3.12	6240	13.8
3/5/2002	457.69	4712.41	-0.36	7.75 (dry)	4.61	6440	14.2
6/28/2002	457.95	4712.15	-0.62	dry			
9/24/2002	458.31	4711.79	-0.98	dry		1	
12/10/2002	457.28	4712.82	0.05	dry			





Well Identification:

TJMW-3 811,183.26

Northing:

1,847,938.86 5029.77

Easting:
Well Casing Elevation (ft):

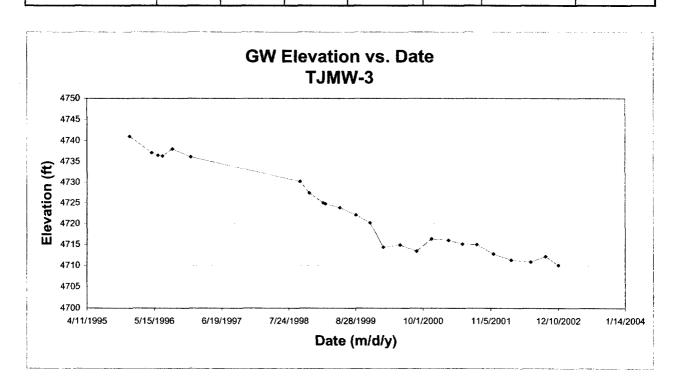
(Well Casing Extended 2/8/00)

Well Depth (ft): Well Bottom Elevation (ft):

319 4710.77 322.86 4710.77

5033.63

Measurement Date (m/d/y)	Groundwater Depth (ft)	Groundwater Elevation (ft)	Column of Water (ft)	Purge Volume (gals)	Final pH (pH units)	Final Conductivity (mmhos)	Final Temperature (°C
12/20/1995	288.73	4741.04	30.27	80	7.59	2800	9.5
4/29/1996	292.65	4737.12	26.35	75	7.25	3200	12.8
6/6/1996	293.28	4736.49	25.72	75	7.4	3100	19.8
7/3/1996	293.44	4736.33	25.56	75	7.34	2400	18.3
8/30/1996	291.75	4738.02	27.25	75	7.14	2200	17.5
12/18/1996	293.64	4736.13	25.36	70	7.21	2100	11.5
9/28/1998	299.55	4730.22	19.45	72	6.79	3270	13.6
11/23/1998	302.32	4727.45	16.68	53	7.33	3280	12.4
2/15/1999	304.72	4725.05	14.28	55	7.47	3250	12.2
3/1/1999	304.96	4724.81	14.04	34	7.48	3260	12.1
5/26/1999	305.88	4723.89	13.12	55	7.49	3230	12.9
8/30/1999	307.64	4722.13	11.36	45	7.11	3190	13.2
11/22/1999	309.54	4720.23	9.46	45	6.89	3270	11.7
2/8/2000	315.37	4718.26	7.49	22 (dry)	7.15	3240	12.2
5/18/2000	314.85	4718.78	8.01	26	7.21	3260	13.1
8/24/2000	316.34	4717.29	6.52	25	7.68	3130	14.8
11/20/2000	317.27	4716.36	5.59	25	6.57	3140	11.7
2/28/2001	317.58	4716.05	5.28	50	6.87	3130	11.7
5/21/2001	318.47	4715.16	4.39	39	6.81	3000	12.7
8/15/2001	318.63	4715.00	4.23	3 (dry)	7.01	3040	16.7
11/20/2001	320.84	4712.79	2.02	15 (dry)	7.23	3025	12.4
3/5/2002	322.31	4711.32	0.55	dry			
6/28/2002	322.74	4710,89	0.12	dry			
9/24/2002	321.46	4712.17	1.40	dry			
12/10/2002	323.54	4710.09	-0.68	dry			





 Well Identification:
 TJMW-4

 Northing:
 810,352.05

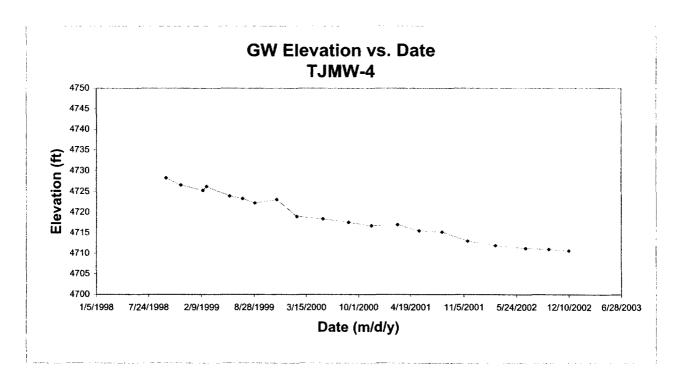
 Easting:
 1,848,456.17

 Well Casing Elevation (ft):
 5071.43

 Well Depth (ft):
 365

 Well Bottom Elevation (ft):
 4706.43

Measurement	Groundwater	Groundwater	Column	Purge Volume	Final pH	Final	Final
Date (m/d/y)	Depth (ft)	Elevation (ft)	of Water (ft)	(gals)	(pH units)	Conductivity (mmhos)	Temperature (°C)
9/28/1998	343.15	4728.28	21.85				
11/23/1998	344.84	4726.59	20.16	55	6.71	3110	12.5
2/15/1999	346.15	4725.28	18.85	45	7.47	3000	12.3
3/1/1999	345.21	4726.22	19.79	44	6.54	3260	12.5
5/26/1999	347.53	4723.90	17.47	-	-	-	-
7/14/1999	348.12	4723.31	16.88	-	-	-	-
8/30/1999	349.21	4722.22	15.79	36	6.50	2870	13.4
11/22/1999	348.37	4723.06	16.63	38	6.09	2830	11.9
2/8/2000	352.48	4718.95	12.52	44	7.02	2970	12.6
5/18/2000	353.03	4718.40	11.97	38	6.13	3000	13.0
8/24/2000	353.91	4717.52	11.09	52	7.17	3030	13.6
11/20/2000	354.71	4716.72	10.29	38	6.77	3040	12.6
2/28/2001	354.45	4716.98	10.55	55	6.88	3030	12.3
5/21/2001	355.96	4715.47	9.04	38	6.69	2900	13.2
8/15/2001	356.28	4715.15	8.72	50	7.16	2890	14
11/20/2001	358.47	4712.96	6.53	38	7.2	2925	13
3/5/2002	359.56	4711.87	5.44	29	7.22	2970	12.3
6/28/2002	360.22	4711.21	4.78	25	7.16	2890	15.1
9/24/2002	360.47	4710.96	4.53	19	7.19	3000	13.1
12/10/2002	360.84	4710.59	4.16	36	7.13	2840	12.1





 Well Identification:
 TJMW-5

 Northing:
 810,800.56

 Easting:
 1,847,286.96

 Well Casing Elevation (ft):
 5070.9

 Well Depth (ft):
 365

 Well Bottom Elevation (ft):
 4705.9

Measurement	Groundwater	Groundwater	Column	Purge Volume	Final pH	Final	Final
Date (m/d/y)	Depth (ft)	Elevation (ft)	of Water (ft)	(gals)	(pH units)	Conductivity (mmhos)	Temperature (°C)
9/28/1998	343.81	4727.09	21.19				
11/23/1998	341.96	4728.94	23.04	52	7.11	3730	12.5
2/15/1999	339.85	4731.05	25.15	53	6.88	3710	12.2
3/1/1999	345.51	4725.39	19.49	42	7.13	3760	12.2
5/26/1999	345.51	4725.39	19.49	52	6.98	3760	12.9
7/14/1999	347.72	4723.18	17.28	45	6.97	3760	13.2
8/30/1999	348.46	4722.44	16.54	52	7.08	3750	13.0
11/22/1999	341.47	4729.43	23.53	52	6.59	3730	11.8
2/8/2000	349.92	4720.98	15.08	48	6.75	3775	12.0
5/18/2000	345.47	4725.43	19.53	52	6.63	3780	12.8
8/24/2000	350.92	4719.98	14.08	55	6.94	3710	14.7
11/20/2000	353.53	4717.37	11.47	55	6.16	3600	12.0
2/28/2001	354.41	4716.49	10.59	48	6.37	3590	11.7
5/21/2001	352.14	4718.76	12.86	50	6.7	3500	12.1
8/15/2001	356.81	4714.09	8.19	52	6.23	3420	13.3
11/20/2001	357.97	4712.93	7.03	38	6.82	3420	12.7
3/5/2002	359.24	4711.66	5.76	38	7.46	3570	12.9
6/28/2002	359.61	4711.29	5.39	35	6.82	3590	13.4
9/24/2002	359.97	4710.93	5.03	32	7	3650	13.1
12/10/2002	360.46	4710.44	4.54	53	6.99	3500	12.1

